DRAFT REPORT

INTEGRATION OF ENVIRONMENTAL POLICIES IN THE INDIAN ENERGY AND TRANSPORT SECTORS

Integration of Environmental Policies in the Indian Energy and Transport Sectors

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Integration of Environmental Policies in the Energy and Transport Sectors in India

Introduction

The energy sector plays a pivotal role in the overall development of the economy. Planning for the energy sector has therefore held considerable importance since the inception of the economic planning process in 1951. However, the policies governing the pattern and composition of economic growth have historically resulted in overuse and misallocation of scarce natural resources, leading to escalating environmental costs. Integrating economic growth and sustainable development is a formidable challenge for any developing country confronting more fundamental problems of providing basic services to a burgeoning population. However, it is essential to understand the inextricable economy- demography -environment linkages and that unless sectoral development policies integrate these facets, the very process of economic and social development would turn out to be self-defeating.

This reports attempts to examine the energy and environment policies in India with a view to identify the extent to which environmental concerns have been integrated into the economic development process, the institutional and political barriers to such an integration, and the measures through which changes can be effected. However, it would be in order first, to analyse the imperatives for an integrated policy approach in terms of the extent of environmental degradation and the causes thereof.

Environment and poverty linkages

The poor are both victims and agents of environmental damage. Population growth, paucity of resources and lack of economic opportunities create pressure for the poor to exploit ecologically fragile marginal rural and urban environments for survival. Resource degradation thus caused jeopardizes growth in the long run and leads to more poverty since poor are directly dependent on natural resources for their survival. Data for several developing countries indicates that a map of absolute poverty coincides with areas of environmental degradation (UNEP 1995). We examine below poverty implications and poverty-environment relationship in the two sectors under study - energy and transport.

Energy and poverty

Energy in itself is not a basic human need. However, it is required for meeting any and all of the basic needs - food, shelter, health, education, employment, etc. These needs may be met through various energy carriers- biomass, charcoal, coal, kerosene, electricity and LPG to name some. Together these carriers are commonly referred to as an "energy ladder" as shown in Figure 1. The figure illustrates that with increasing incomes, people shift to more efficient, cleaner, and more expensive but convenient fuels. Insofar as total energy use increases sharply with income, the ladder may also be thought to widen as one climbs its rungs. Data on cooking fuels in households classified by monthly per capita expenditure (MPCE) in both rural and urban areas in India supports the notion of an energy ladder. (Figures 2 & 3). It is revealing to note here that in a predominantly rural country, around 78% of rural (and 30% of urban) households depend on firewood and chips. Cross-country data is also consistent with the concept of an energy ladder. (Reddy et al, 1997). Thus both poor countries and people living in poverty within these countries are disproportionately positioned on the lowest rung.

Figure 1. Energy Use Ladder

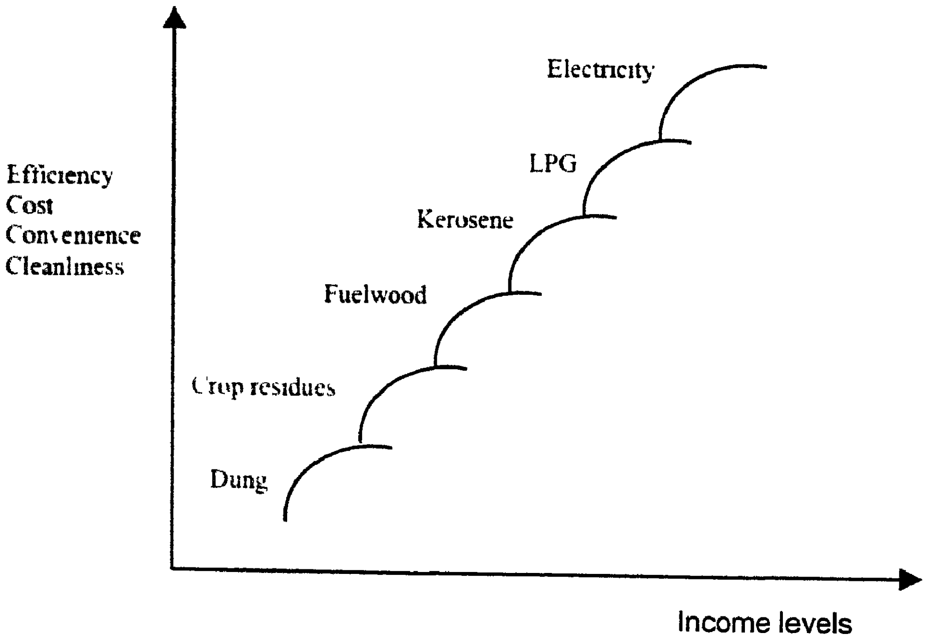


Figure 2. Urban households using primary fuel for cooking across income classes

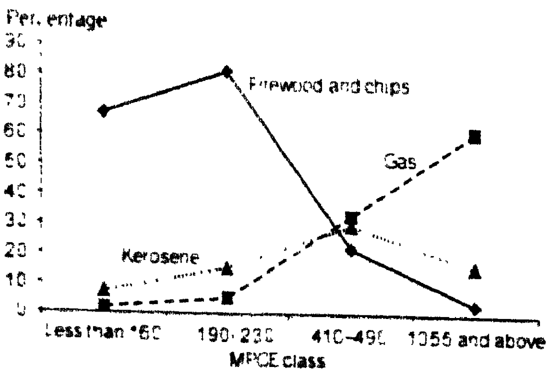
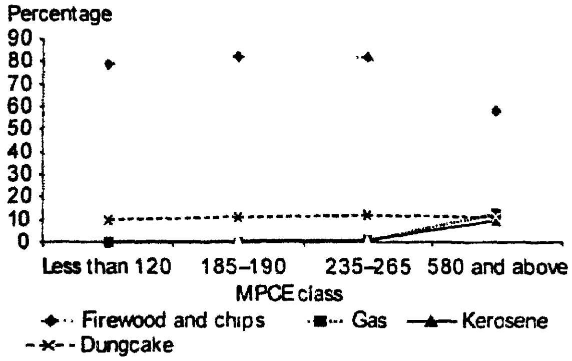


Figure 3. Rural households using primary fuel for cooking across income classes.



Source: NSSO (1997) as cited in TERI 1999a

Current patterns of energy consumption among the poor tend to further aggravate poverty. This is so since the poor pay a much higher price for energy services than any other group in society. The price can be measured in terms of time and labour, health and social inequity, particularly for women. Among the most serious costs of energy scarcity for the poor are - the range of health problems it causes. Compared to LPG and kerosene, traditional fuels generate more respirable particulate matter (RSP), Carbon monoxide, sulphur oxides and polyaromatic hydrocarbons. Women and children in poor households are the most exposed to these pollutants, making them vulnerable to acute respiratory infections, chronic pulmonary diseases, cancer, tuberculosis, blindness, etc. A survey of 80 urban households in 2 slums of Delhi noted that daily exposure of infants to RSP in wood and kerosene using households is 10-16 and 10-12 times the WHO limit (TERI, UNEP 1999). Infact the total human exposure to many important pollutants may be much more substantial in the homes of the poor in developing countries than in the outdoor air of cities in the developed world, due to high concentrations and the large population involved. Besides the health impacts, low levels of energy services are a serious obstacle to social and gender equality. The poor, especially women invest a large portion of their most important asset, their time to the production of energy services. Women and girls in poor households are trapped in an unceasing cycle of work that deprives them of education and equal participation in local development programmes. A study conducted by the Centre for Science and Environment in a Himalayan village found that women put in 59% of the total annual work hours in the village, children 26% and men only 15 % (CSE 1999). Another implicit cost is the extremely low efficiency (i.e. the fraction of energy released from the carrier that is actually turned into an energy service by the end-use devise) of traditional fuels. The cook-stove efficiencies of firewood, kerosene, and gas are roughly 15%, 50% and 65%

respectively. (Reddy et al,1997). Added to these costs should be the social costs of deforestation and land degradation caused by dependence on firewood.

There may be other dimensions of energy- poverty linkages. The development of hydropower for instance, unless properly planned can lead to large-scale dislocation of people. In India, an estimated 14-22 million people have been displaced by dams (CSE 1999). Displacement often results in loss of land, homes and jobs, marginalization, food insecurity, health problems, loss of access to common property assets and community disarticulation.

Transport and poverty

The linkages between transport systems and poverty may be more difficult to draw than energy and poverty. It is clear however that the urban poor are burdened with a disproportionate share of pollution due to vehicular exhaust. Much of the air congestion in developing world cities is caused by private vehicles or taxis and rickshaws used by the more wealthy citizens. Such vehicles take up significantly more road space per passenger than public transport. In Karachi, cars cover 44% of passenger miles but use up 83% of road space (UNEP, 1995). In India, buses form just over 1% of more than the 38 million registered vehicles. However associated respiratory illness mostly afflict the poor, who often cannot afford to live in areas safely distanced from smoke-stacks. They also suffer the most from city congestion, because they often live far from where they work and must use slow public transport. It was estimated for Bogotá that the average low-income adult spends 127 minutes commuting per day, 44 minutes more than high-income travellers (UNEP, 1995).

Factors responsible for Environmental Degradation

Environmental impacts are a result of the dynamic interplay of socio-economic, institutional and technological factors. Environmental impacts may be driven by a host of factors including economic growth, population growth, urbanisation, intensification of agriculture, changing patterns of energy consumption and structural changes in the economy Further, there exists an important though complex relationship between poverty and environment. The poor rely directly and to a significant extent on natural resources This means that not only does inequality foster unsustainability but also that a degraded environment can accelerate the process of impoverishment.

Social Factors

There exist important linkages between environment and population growth, the level of urbanisation and income distribution of population. While India is predominantly rural, its urban population has increased rapidly, at almost twice the average rate of growth of population. Post independence, in 1951 the urban population was around 62 million (17%of the total population), that had exploded to 218 million (26%) by 1991 and 244 million (26%) by 1996. It is estimated that by 2011 about 430 million people (nearly 37%) will be living in towns and cities, making it the largest urban population of the globe (as cited in Gupta 1999). The per capita water requirement is estimated at 40-120 litres/day while the energy requirement is estimated at 290 kgoe/capita/day and sewage disposal and sanitation requirements are pegged at around 0.2-0.5 kg per day (TERI 1999a). With these levels, the impacts on the environment (even at the current levels of use per capita) will be enormous. Population in almost all urban centres already seems to have crossed the threshold limits of support systems. This is reflected in multiple and complex environmental problems confronting cities. First, under population pressure, the environmental resource base of cities has depleted at a rapid rate. Second, on account of the changing composition of manufacturing output and increased motorization, pollution levels in many Indian cities are far in excess of the "safer limits", and are amongst the highest in the world. Third, most cities are facing problems on the one hand, of availability of safe water supply, sanitation, and solid waste treatment and disposal facilities, and on the other hand, of overcrowding, congestion, and occupation of environmentally sensitive lands. The deterioration of living conditions is glaring in slum areas, which constitute about 20 to 30% of the urban population. The slum population in urban India alone outnumbers the total population of all but 25 countries in the world. (TERI, MoEF 1995)

Economic factors

To a large extent, environmental degradation is the result of market failure, that is non-existent or poorly functioning markets for environmental goods and services. Lack of well-defined property rights may be one of the reasons for such market failure. Market distortions created by price controls and subsidies further aggravate the problem.

The level and pattern of economic development also affect the nature of environmental problems. As the Indian economy has grown, the relative importance of various sectors has changed. During 1991-98 alone, the share of agriculture in the GDP declined from 32.8% to 28.7%, while the shares of industry and services increased by 1.4% and 2.7%, respectively. However, the agriculture sector continues to hold an important position with agriculture and allied activities being the single largest contributor to GDP and employing as much as 65% of the total Indian workforce. However, over the last 30 years, it has become increasingly clear that the high yield variety seed-chemical fertiliser centred technological revolution is not an unmixed blessing. The extension of irrigation facilities, modernisation and mechanisation of agricultural operations and the extensive use of fertilisers and pesticides that yielded major gains in productivity have had far-reaching environmental consequences. These include degradation of soils from overuse of chemical fertilisers, health hazards caused by pesticides, decline in crop diversity, depletion and deterioration of groundwater, waterlogging and salinity.

The industrial sector of the country has grown sharply since 1980/81, with industrial growth rates exceeding overall GDP growth. Between 1994/95 and 1997/98 alone, while the economy grew a little over 7% per annum, the growth of industrial production and manufacturing averaged higher at 8.4% and 8.9% respectively. In terms of total output, Indian industry ranks amongst the top in the world. The Indian Cement industry for instance is estimated to be the fourth largest in the world. With a high proportion of fossil fuels being used in the industry sector, the industrial sector has contributed to a relatively high share in air pollution besides compounding the problem of effluents and solid waste. Apart from the major energy intensive industries including iron and steel, fertilisers and cement, small and medium scale industries, the unorganised industrial units (around 3 million) like leather tanneries and foundries are growing rapidly. Trends indicate that not only have pollution loads risen with economic growth, but in some cases, at even higher rates than the latter. Between 1963 and 1991, industrial output in India has quadrupled, growing at an average annual growth rate of about 5.5%. Toxic releases during the same period grew six fold at approximately 7% per annum, as shown in Figure 4 (World Bank 1996 as cited in TERI, 2000c).

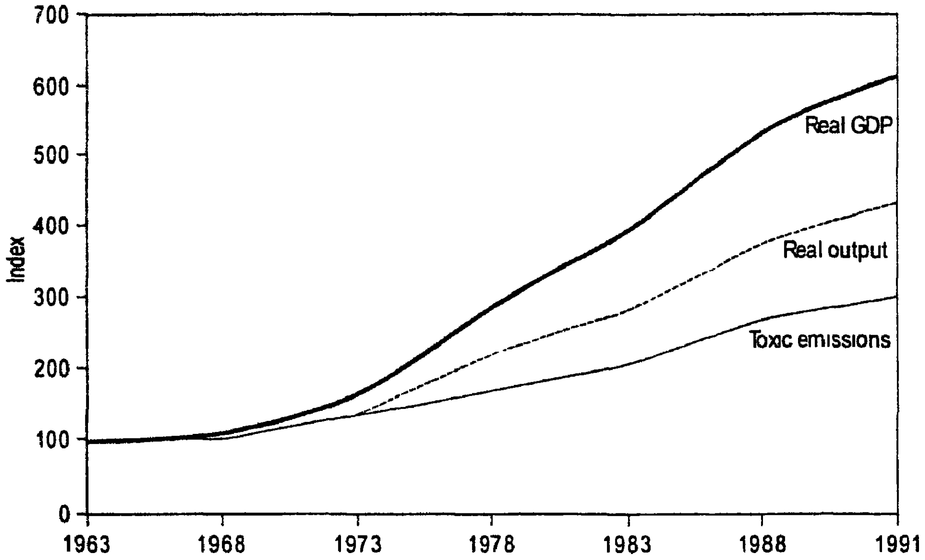


Figure 4 Toxic pollution and industrial growth, 1963-91 [World Bank 1996]

Political and Institutional Factors

The existing political and institutional barriers in integrating environmental policies in energy and transport sectors are discussed below.

1. The energy and transport sectors have been dominated by public investment. Recently there has been some movement towards dilution of this domination – introduction of the private sector in oil exploration/production and refining, in power generation and to a limited extent in distribution and again to a limited extent in city and inter-city road passenger transportation. The only significant exception has been the transportation of goods by road, which is dominated by the private sector.
2. The domination of these sectors by public investment has meant that the management of the various enterprises has been driven by conflicting objectives, of both improving efficiency as well as serving the "equity" objectives as perceived by the government of the day. In large part, the conflict between the agricultural sector and the rest of the economy has also played a role in determining the agenda of the government. Given the historical background of India's precarious food position, in the early post independence period, the agricultural sector has been given a certain priority and prominence and Government intervention in favour of this sector has been justified on grounds of promoting national food security.
3. Against this background, it is easy to see the reasons for extensive under recovery of costs in the agricultural sector, whether we consider oil products on one hand or electricity on the other. Diesel prices had till recently been placed below cost and in the past whenever these prices have been raised, the Government had invariably

been forced to partially rollback the increase. In the case of the electricity sector, in several states electricity is provided free to farmers while in many others only a flat rate is charged. Even where there is metering, the revenue recovered is substantially below cost. These developments have taken place over the last two decades and can be seen as a direct result of the extensive agitation by farmers in the 1970's.

4. Over time it has been increasingly realised that these policies are not sustainable. In the oil sectors, a decision had been taken to link domestic prices with international prices and to bring in the private sector in a bigger way. At the time when the decision was taken, international prices of oil were low and the impact was not felt. However, as international oil prices rose, it became increasingly difficult to adhere to these principles and an element of cross subsidy has again crept in. Apart from farmers there is also extensive subsidy of kerosene and LPG, which has been brought out in the other parts of this report.
5. In the case of electricity, again it has been increasingly realised that this method of appeasing the farmers is not sustainable, as under-pricing has led to improper accounting of electricity and the rapid deterioration in the financial health of the electricity boards which in turn has led to poor service. It is for this reason that the governments both at the centre and in the states have increasingly chosen to divest themselves of the powers of tariff fixation in favour of independent, autonomous, regulatory commissions.
6. The first state to embark on this path was Orissa and it is too early to say whether the reform has succeeded or not. In other states the reform process is at a much more nascent stage. However the experience in Orissa suggests that by merely removing the decision making powers on these politically sensitive issues, to a non-political, professional body will not achieve results. As long as ownership remains with the government it would not be possible for the government to distance itself from politically difficult decisions and ultimately privatisation was felt to be the more politically acceptable decision. Therefore in Orissa the distribution business was privatized in last year Hopefully with this, there will be an improvement in the financial performance of the sector. In other states although the electricity boards have been broken up into separate business entities, actual privatization of distribution has not yet taken place. Private generation has come in a modest way in some states but this has had no impact on proper retail pricing and the environmental hazards of improper pricing. This still remains a political barrier as trade unions have vehemently opposed this aspect of reform. For the reform process to succeed, it

would be necessary to overcome this barrier also as without institutional change it is unlikely that there will be any sustainable improvement.

7. In the transport sector again the problem has been the domination by the public sector and its control by the Government. State Governments do not wish to take hard decision on raising passenger tariffs. This has lead to the poor financial health of the public transport system and the existence of an overaged fleet with its concomitant environmental fallout. There has also been a lack of forward planning in large cities and this again has been due to the short-term perspective of most governments. It is only when a problem assumes crisis proportions that the appropriate institutional response has come in the form of underground/elevated transport systems. Similarly at the central level, the Government of India has not been able to resist the temptation of the politically soft option of subsidising passenger traffic at the expense of freight traffic. This has led to an overuse of road transport, which is less energy efficient.
8. The major institutional/political barrier in all these areas has been the control by government, which necessarily has to take into account short term political calculations. To overcome these constraints it is necessary that markets are allowed to work wherever they can. Where monopolies are inevitable, regulation should be in the hands of independent, autonomous, professional bodies. There is also immense need for information dissemination and education of the "vote banks" that compel governments to adopt short-run policies. They need to be convinced that while these policies may bring immediate gains they will in the long run, impair the delivery of services and lead to environmentally inferior solutions.

Environmental Problems in India

The main environmental problems in India include air and water-related pollution, waste disposal, soil degradation, loss in biodiversity and forest reserves etc. These problems and their underlying causes are discussed in the following sections.

- Air Pollution

  Increased traffic, industrial expansion, and lack of comprehensive environmental regulations/enforcement have combined to produce unacceptably high levels of air pollution. Results of analysis of air quality data by Central Pollution Control Board (CPCB) for the period 1987-94 reveal that (TERI, 1998):

  - Air quality was rated dangerous or bad in 34 out of 62 Indian cities in 1994. Only 7 cities were categorised as having air quality at an acceptable level.

  - Pollution due to SPM (suspended particulate matter) is widespread in most Indian cities, and in a few of them, levels of SO_2 (sulphur dioxide) or NO_x (oxides of nitrogen) are high as well. Air in 60 out of 62 cities contained more particulate matter than what is considered safe by WHO guidelines.
  - The estimated pollution load due to motorised transport in 1997 was 68 times that in 1947.
  - The annual loss due to the adverse effects of polluted air is estimated at US $ 24–114 billion.

- Water Pollution

  The analysis of water quality data from CPCB (1979-1991) shows that:

  - Out of the 80 districts in the Yamuna river basin, the number of highly stressed districts rose from 1 in 1947 to 20 in 1997. These districts are highly stressed either due to excessive depletion in quantity or excessive deterioration in quality of water resources. At present, 42 districts fall in the medium stress category.
  - River water in most parts of the country is found to be polluted in terms of high levels of Biochemical Oxygen Demand (BOD – 3.5 to 80 mg/L) and coliform bacteria (4.00e+03 to 6.00e+11). The safe limits for BOD & coliform bacteria as per the CPCB classification of class C water (drinking water with conventional treatment) are 3 mg/L and 5000 MPN/100 mL.
  - Excessive use of fertilisers has led to an increased level of nitrates in the shallow groundwater sources.
  - A survey of groundwater quality in 22 industrialised zones conducted by CPCB in 1994 has revealed that in none of the 22 areas was the water fit for drinking. It was found to be contaminated with heavy metals, chemicals such as fluoride and phenols, and coliform bacteria.
  - The annual economic losses due to the adverse effects of poor quality drinking water on human health are estimated to be US $ 3 billion.

- Solid Waste Management including Hospital Waste

  Solid waste management has emerged today as a major environmental issue. It has reached alarming dimensions in terms of the amount of waste generated and limited options for its disposal. The analysis of solid waste generation data shows that:

- The solid waste generated in Indian cities increased from 6 million tonnes in 1947 to 48 million tonnes in 1997.

The production and consumption of plastic increased more than 70 times between 1960 and 1995.

More than one-fourth of the municipal solid waste is not collected at all; 70% of Indian cities lack adequate capacity to transport it; and sanitary landfills to dispose of the waste are neither well-equipped nor managed efficiently.

In addition, in absence of any regulation, till very recently the municipal waste dumps were/are also receiving infectious health care waste generated from various hospitals and health care systems in country

Industrial/Hazardous Waste Management

- The estimated generation of hazardous waste in India is approximately 3 million tonnes annually.
- In addition, around 80 million tonnes of fly ash gets generated annually from thermal power plants.
- The industrial sector generates about 100 million tonnes of non-hazardous solid waste and 2 million tonnes of hazardous waste every year.

Climate change

- The increase in emission of greenhouse gases (GHGs) due to increased combustion of fossil fuels contributes to global warming and climate change. It is estimated that over the period 1980-90, 46% of total GHGs emissions were due to combustion of fuels (IPCC Secretariat 1990).
- In 1990, total carbon dioxide equivalent emissions from India were 1,001,352 Gg, which approximately amounted to three per cent of total global carbon dioxide equivalent emissions. Based on this, the per capita carbon dioxide equivalent emissions for 1990 were 1.194 tonnes (325 kgC).
- The energy sector was the largest contributor of carbon dioxide emissions in India. The carbon dioxide equivalent emissions from this sector were 565 245 Gg, amounting to nearly 55% of total national emissions. These included emissions from road transport, burning of traditional biomass fuels, coal mining, and fugitive emissions from oil and natural gas.
- Another major contribution to the GHG emissions, to the tune of nearly 34%, came from the agricultural sector and included emissions from enteric fermentation in domestic animals, manure management, rice cultivation, and burning of agricultural residues. The carbon dioxide equivalent emissions from this sector amounted to 341 064 Gg.

- Emissions from industrial processes were mainly from cement production, the total carbon dioxide equivalent emitted from this sector being 24 510 Gg.
- The net carbon dioxide uptake and emissions from the land-use change and forestry sector were almost equal, resulting in negligible emissions from this sector.
- The total methane emitted from the waste sector was 3288 Tg, which amounted to 69 048 Gg in carbon dioxide equivalent terms.

- Biodiversity

  India occupies only 2.4% of the world's land area but its contribution to the world's biodiversity is approximately 8% of the total number of species, estimated to be 1.6 million. Among the 18 hot spots identified for biodiversity in the world, two are located in India – in the Eastern Himalayas and the Western Ghats.

  The rich biodiversity of India is under severe threat owing to habitat destruction and over-exploitation of resources. It is now estimated that of the 1,500 species of plants that are listed as threatened, 33 have gone extinct, 157 are endangered, 114 are vulnerable and 246 are rare (Nayar and Shastry 1988, 1989 and 1990). Nearly 23 animal species, including the cheetah, are known to have become extinct and many more could have vanished (WCMC 1992, Khoshoo 1996). It is also estimated that among the animal species, 91 mammal species, 21 amphibian and reptile species, and 40 birds species are reported to be endangered (Mukherjee 1994).

  - Among the major proximate causes for loss of India's biological diversity is habitat destruction and degradation coupled with over-exploitation of resources. Destruction of forest land and the erosion of biodiversity is largely due to the expansion of various development projects such as mines, dams, and road and canal construction.
  - It is estimated that, after Independence, the country has lost 4696 million hectares of forest land to non-forestry purposes.
  - While 0 07 million ha of forest land has been illegally encroached upon, 4.37 million ha has been subjected to cultivation, 0.52 million ha given to river valley projects, 0.14 million ha to industries and townships, 0.06 million ha for transmission lines and roads; and the rest for miscellaneous purposes.
  - Habitat loss and fragmentation leading to the formation of isolated, small, scattered populations is one significant obstacle. These small populations are increasingly vulnerable to inbreeding depression, high infant mortality,

susceptibility to environmental stochasticity, and, in the long run, possible extinction.

- Changes in forest composition and quality and, in turn, habitat type lead to declines in primary food species for wildlife.
- Poaching is another insidious threat that has emerged in recent years as one of the primary reasons for extinction of species such as the tiger. Poaching pressures, however, are unevenly distributed since certain selected species are more heavily targeted than others.
- Population pressures and concomitant increases in the collection of fuelwood and fodder, and grazing in forests by local communities also take their toll on the forests and consequently its biodiversity.

While the proximate causes of biodiversity loss are easy to delineate, the underlying causes for these unsustainable patterns of resource degradation and overuse are manifold and complex and lie in the realm of institutional, governance, economic, policy and technological failures. Prominent amongst them are development pressures stemming from the need for a nation's economic augmentation accompanied by high levels of population growth. Markets also fail to capture the true value of biodiversity and thus incentives for its conservation are reduced.

- Deforestation and Soil Degradation

  Till 1980, India's forest cover was being lost at the rate of 144,000 hectares per year (TERI, 1998). Although it slowed down to 24,533 hectares per annum between 1980 and 1995, reversing the trend and halting the process of degradation continues to remain a major policy issue. Widespread deforestation in the catchment area of the Himalayas is leading to environmental backlash in the form of flooding and droughts, soil erosion, sedimentation and siltation in the flood plains of the Ganga and the Brahmaputra among other major rivers. Desertification, a potential and severe consequence of deforestation in arid, semi-arid, and dry sub-humid regions, can have untold ecological and social repercussions. Of the total area of around 328.7 million hectares, the extent of area under the threat of desertification in India is about 83.6 million hectares. Soil resources are also getting polluted with indiscriminate disposal of industrial effluent and solid waste, municipal and sewage sludge and agricultural chemicals such as pesticides and fertilisers

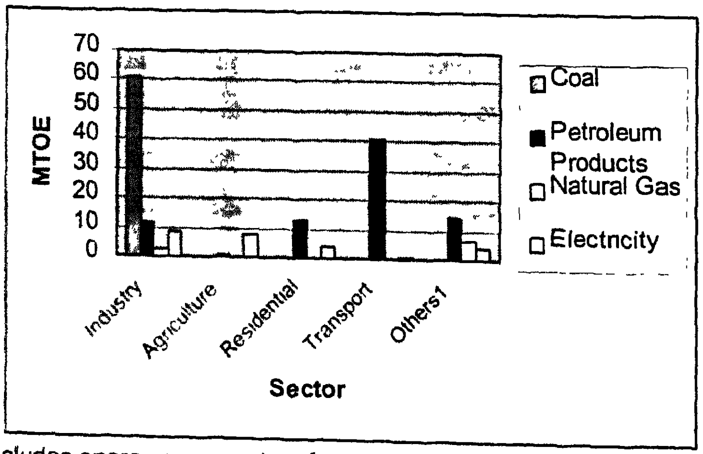
It is clear from the above discussions that environmental degradation is a result of the excess pressure that economic growth puts on our dwindling natural resources. In the following sections we review the environmental impacts of the energy and transport sector, and the existing policies, legislation and organisation structure of the energy & environment sectors in India. This is followed by a matrix representation that reviews existing policies, barriers to their successful integration and identification of recommendations for the energy sector. Finally, the interventions required to remove these barriers and ensure implementation of the recommendations are discussed for the energy and transport sectors.

Review of Energy Sector Policy and Planning

Impact of the Energy Sector on Environment

The energy sector plays a pivotal role in the overall development of the Indian economy. Industrialisation and urbanisation have resulted not only in the overall increase in total energy demand but also in increased levels of per capita energy consumption. Between 1987-97, primary energy consumption has increased at 7.7% per annum. (TERI 1999a). The per capita commercial energy consumption has also increased from 152.7 Tonnes of Oil Equivalent in 1991 (TOE) to 176.08 TOE in 1997/98. Specifically, while the world energy consumption grew by 1% during 1997 over the previous year, it grew by 6.1% in India. The sectoral consumption pattern shows that industrial sector is the largest consumer of energy, followed by the transport sector, the latter being the largest consumer of petroleum products. The sectoral consumption pattern of energy in 1997/98 is shown in Figure 5 below.

Figure 5. Sector-wise Consumption of Energy in 1997/98

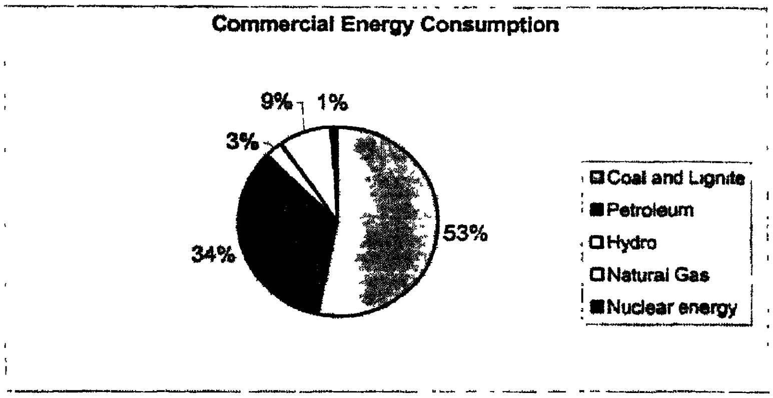


[1] includes energy consumption for other energy and non-energy uses.

Overall, India continues to be a net importer of energy. In 1997/98, nearly 22% of the energy supply was through import in the form of coking coal, crude oil, and petroleum products. The oil import bill in 1997/98 constituted about 24% of the export earnings during the period.

Environmental concerns in the energy sector stem mainly from the fact that coal remains the primary source of energy in the country as is reflected in Figure 6 below.

Figure 6. Commercial energy consumption



In the power sector, thermal power constitutes about 72% of the total installed power generation capacity. Increasing reliance on thermal power leads to many environmental problems. The poor quality of coal available for power generation (ash content – 35% to 45%) results in high emissions of fly ash per unit of electricity. In addition to emission of fly ash, thermal power generation also produces high levels of suspended particulate matter (SPM) and sulphur dioxide (SO_2). Moreover, unplanned and indiscriminate mining methods result in land degradation in and around the coalfields.

The continued dependence on traditional energy forms by a significant section of the population for meeting their energy needs also results in high levels of indoor air pollution and degradation of forest areas.

Decision Tree Analysis

Thus far we have identified the environmental impacts arising in the energy sector. To mitigate these impacts, it is needed to integrate these impacts in a framework that would facilitate identification of limitations in policies and recommendations in energy sector. This can be achieved by undertaking a 'decision tree' analysis for energy sector. The 'decision tree' analysis enables a holistic assessment of the factors driving energy demand, the options to meet this demand and the resultant environmental stress in various stages of the fuel supply and use chain (Figure 7 below). We examine these factors in turn.

Drivers of Energy Demand

Population and economic growth are the main drivers of energy demand. Further, the spatial distribution of population, that is the level of urbanisation has implications for the pattern of energy demand. The quantum of energy requirement is less in rural areas and the quality of energy services required is also different. In addition, the access of poorer sections of society residing in rural areas to commercial sources of energy is limited by their lower purchasing power, which increases their dependence on forest resources. Growth of value added in the various sectors of the economy, industry, agriculture, transport and commercial in turn leads to an increase in energy demand. For instance, rising per capita incomes increase commercial energy demand in the residential sector and increasing output increases energy demand directly in the industrial and commercial sectors. Technological innovations may reduce energy intensity in these sectors; however, growth in these sectors is likely to result in an increase in absolute energy consumption levels.

Options to meet energy demand

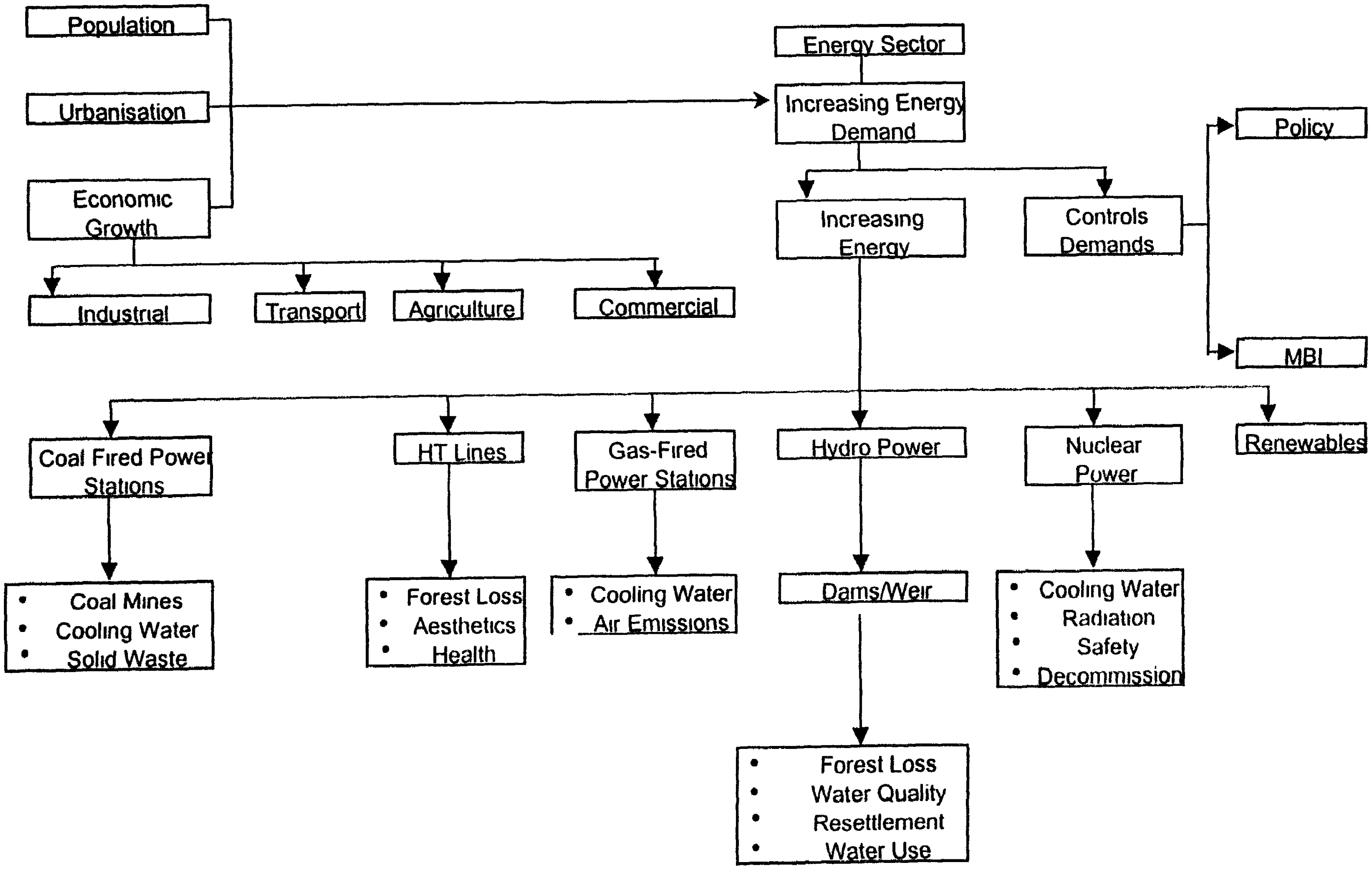
Increasing energy demand can be met by increasing energy supply and by exercising control over energy demand. At the same time, preferred policy options would be those that both meet energy demand and are environmentally friendly. The control on demand could either be policy driven such as demand side management measures in the power sector, or through the use of market based instruments. Better targeting and phasing out of energy subsidies would yield a double dividend of limiting environmental degradation and raising resources. Energy demand can be met by increasing energy supply, by increasing the supply of conventional energy sources like coal, oil and gas, electricity as also the supply of renewable energy.

Environmental impacts

Of the options to meet energy demand, increasing energy supply though more direct, is associated with an increase in the environmental impacts of, for example, power generation, mining and transportation of gas. Some of these impacts include deterioration in forest cover, deterioration of ambient air quality and pollution of water bodies. Thus it is imperative that environmental impacts be mitigated through the introduction of MBIs that internalise the environmental costs of production. The higher costs when passed on to the consumer in the form of higher prices would help reduce demand and thereby limit environmental impacts. Some MBIs that might be considered include charges on emissions, effluents and products.

Thus the identification of environmental impacts and the options for meeting increasing energy demand enable an integrated analysis of energy policy options that are environmentally friendly and meet energy demand efficiently.

Figure 7. Decision Tree for Energy Sector



Organisational framework

The organisational framework of the Union Government and the related agencies in the energy sector is depicted in Figure 8. Under Government of India, a multitude of ministries and organisations are vested with the responsibility for providing sustainable energy development. However, the forum and structure for co-ordinated action among all these separate authority centres are not well defined. Also there exists very limited integration of planning among these ministries. In this section we identify the rules and regulations governing the energy sub-sectors and the nodal organisations in each.

Power

Prior to 1947, the supply of power in India was a predominantly commercial venture undertaken by privately owned utilities located in and around urban areas. There was little co-operation and co-ordination among these private undertakings as their area of activities were isolated and often located far apart. The various Acts and Rules relevant to power generation and distribution in India are summarised in Annex 1 of the report.

The nodal organisations related to policy formulation, project implementation and generation, transmission and distribution of power are presented in Box 1.

Box 1: Organisations in Power Sector

Organisations	**Functions**
Ministry of Power	• Perspective planning, policy formulation, processing investment needs of public sector projects, monitoring of the implementation of the power projects, training and manpower development, and administration and enactment of legislation with regard to thermal and hydel power generation, transmission and distribution. • administration of the Indian Electricity Act (1910), the Electricity (Supply) Act (1948), the Electricity Regulatory Commissions Act (1998) and amendments.
Central Electricity Authority	• advises ministry on technical, financial and economic matters. • responsible for promoting the integration of the state's power systems and providing technical support to the SEBs.
Rural Electrification Corporation	• financing and monitoring rural electrification programmes.
Power Finance Corporation	• financing high priority power projects.
Power Grid Corporation of India	• provider of extra high voltage & high-voltage transmission network in country • formation of national power grid
Central Electricity Regulatory Commission	• regulation of inter-state tariff related matters. • advising central government on formulation of tariff policy. • Framing guidelines pertaining to tariff, promote competition and efficiency in electricity sector.
State Electricity Regulatory Board	• rationalise tariff structure in states. • improve financial health of respective SEBs.

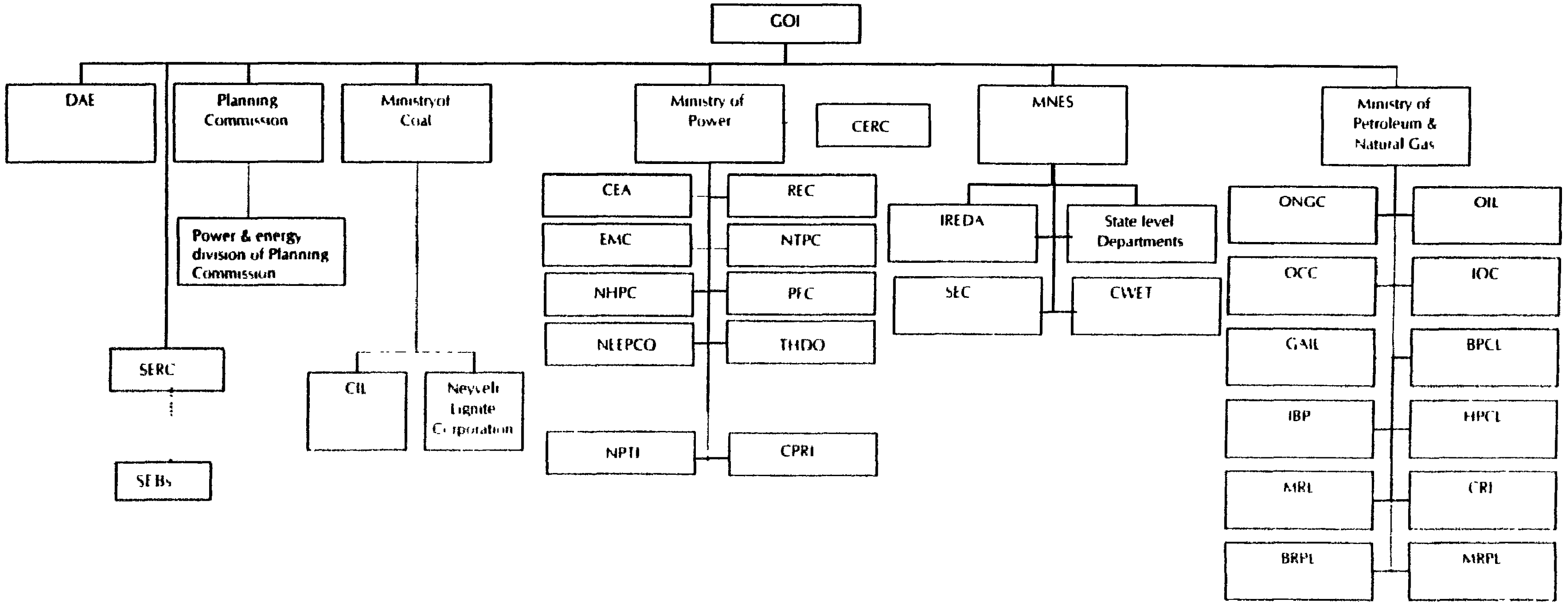


Figure 8. Organisation of the energy sector. BPCL: Bharat Petroleum Corporation Ltd; BRPL: Bongaigaon Refinery and Petrochemicals Ltd, CEA: Central Electricity Authority; CERC: Central Electricity Regulatory Commission; CIL: Coal India Limited; CPRI: Central Power Research Institute, CRL. Cochin Refineries Ltd; CWET. Centre for Wind Energy Technology; DAE: Department of Atomic Energy; EMC: Energy Management Centre; GAIL: Gas Authority of India Limited; GoI. Government of India; HPCL: Hindustan Petroleum Corporation Ltd; IBP: Indo-Burma Petroleum Company Ltd; IOC: Indian Oil Corporation Ltd; IREDA. Indian Renewable Energy Development Agency; MNES: Ministry of Non-conventional Energy Sources; MRL: Madras Refineries Ltd; MRPL: Mangalore Refinery and Petrochemicals Ltd, NEEPCO: North Eastern Electric Power Corporation; NHPC: National Hydro-electric Power Corporation, NPTI: National Power Training Institute, NTPC: National Thermal Power Corporation; OCC: Oil Coordination Committee; OIL: Oil India Limited; ONGC: Oil and Natural Gas Corporation; PFC: Power Finance Corporation; SEBs: State Electricity Boards; SEC: Solar Energy Centre; SERC: State Electricity Regulatory Commission; THDO: Tehri Hydro Development Corporation;

Coal

Various rules, regulations and orders pertaining to coal sector in the country are presented in Annex 1 of the report. The organisations related to policy formulation, project implementation mining and distribution of coal are presented in Box 2.

Box 2: Organisations in Coal Sector

Organisations	**Functions**
Ministry of Coal	• overall responsibility of determining policies & strategies for exploration and development of coal and lignite reserves; • disburses administrative control & sanctions important projects of high value through Coal India Limited & Neyveli Lignite Corporation
Coal India Limited	• lays down policy guidelines & co-ordinates work of its subsidiaries • involved in planning, investment, management, manpower decisions, purchase of heavy machinery and financial budgeting on behalf of its subsidiaries • involved in conservation and R&D of coal mining. The subsidiary companies commission and execute new and ongoing coal mining projects.
Neyveli Lignite Corporation	• lignite production and power generation.

Oil and Gas

The legal framework for regulation of exploration and production of oil and gas is provided by the Oilfields Development and Regulation Act of 1948 and the Petroleum and Natural Gas Rules. The Act has been recently amended to provide for the introduction of New Exploration Licensing Policy (NELP) of 1999. The Directorate General of Hydrocarbons (DGH) was set up in 1993 with the objectives of ensuring the correct reservoir management practices, reviewing and monitoring exploratory programmes, development plans for national oil companies and private companies and monitoring of production and optimum utilisation of gas fields. The downstream sector, comprising the marketing and refining sectors, is regulated mainly by the Indian Petroleum Act and number of control orders passed by the government under the Essential Commodities Act. The Oil Coordination Committee which is under the administrative control of the MoPNG, currently performs the function of a planner, coordinator, advisor, and regulator in the downstream sector.

The organisations related to policy formulation, project implementation and exploration, production and distribution of oil and gas are presented in Box 3.

Box 3: Organisations in Oil and Gas Sector

Organisations	Functions
MoP&NG	• Ensure smooth and systematic functioning of various organisations under its administrative control
ONGC and OIL	• Responsible for exploration and production of oil and natural gas from existing and new oil wells.
IOC,BPCL,HPCL,CRL,MRL,BRPL,NRL,Reliance,Essar	• Refining and marketing of all the petroleum products
IBP Company Limited	• LPG marketing • Provide terminalling facilities • Manufacturer of explosives
Gas Authority of India Limited	• Supply gas to power, fertiliser and petrochemical plants • Extraction of LPG and other hydrocarbons • Involved in laying and operating gas pipelines
Engineers India Limited	• Provide engineering consultancy services for the development of petroleum, petrochemical, ocean engineering and other related chemical engineering development programmes.
Oil Co-ordination Committee	• Co-ordination of various activities of the industry • Co-ordination of supply of crude oil to the refineries • Operation and maintenance of pool accounts • Prepare short term estimates for supply demand and import plans • Monitors the performance of oil industry to achieve optimality • Co-ordination of marketing functions
Oil Industry Development Board	• Provide financial and other assistance for the development of oil industry
Petroleum Conservation Research Association	• Sponsors R&D activities for development of fuel efficient equipment/devices • Organises multimedia campaigns for creating mass enthusiasms for conservation
Oil Industry Safety Directorate	• Assists safety council of the MoP&NG • Develop standards and codes in order to maintain standardisation and keep abreast of latest design and operating practices in the areas of safety and fire fighting in hydrocarbon processing industry.
Centre for High Technology	• Acts as a focal point for the oil industry to co-ordinate and fund research in refining and marketing and for the exchange of information • Assesses technology requirements and prospects for developing these indigenously • Renders advise on scientific and technological programmes • Recommends measures to modernise and improve performance of refineries • Technological think tank of the ministry
Petroleum India International	• Provide resource support to oil companies abroad and thereby export technology and services
Directorate General of Hydrocarbons	• Promote sound management of petroleum & gas resources with regard to environment , safety, technological and economic aspects • Maintains E&P database

The Oil and Natural Gas Commission (ONGC) Limited and Oil India Limited (OIL) expanded their drilling activities in 1981/82 to explore new areas in response to decreasing recoverable reserves in the country and increasing oil demand. Further to this, the poor reserve accretion during the first three years of eighth five-year plan (1992-97) led the government to launch the Accelerated Programme for Exploration. The programme aimed at developing a national seismic grid and exploration in frontier areas and deep waters. So far, the total investment brought into the sector, mostly in the producing fields, exceeds a billion dollars. However, the bulk of this reserve accretion has taken place around the previously discovered fields and no new areas are being explored. The various reasons cited for this being lack of seismic data for new areas, high-risk blocks being awarded to private investors and delays in awarding the production-sharing contracts. The NELP of 1999 seeks to eliminate the most of the problems cited above. Apart from the better terms offered to the bidders, the outstanding feature of this policy is to offer level playing field to national oil companies and private operators.

Renewable Energy

The natural resource base in India has deteriorated due to rapid growth in population, urbanisation and fossil fuel consumption. There are two strategies, which are required to be adopted in parallel to ensure the conservation and proper utilisation of the natural resource base. The first strategy pertains to the appropriate pricing of the exhaustible or non-renewable resources. The second strategy pertains to development and promotion of renewable resources such as biomass, water, wind and solar energy.

The organisations related to policy formulation, project implementation promotion of renewable energy are presented in Box 4.

Box 4: Organisations in Renewable Energy Sector

Organisations	Functions
Ministry of Non-Conventional Energy Sources	• project formulation and planning and overall supervision of development of renewable energy sources.
Indian Renewable Energy Development Agency Limited	• promotion, development and financing the new and renewable sources of energy (NRSE) technologies

As on 31st December 1998, the cumulative sanctions by Indian Renewable Energy Development Agency Limited (IREDA) amounted to US $ 0.6 billion and disbursements were US $ 2.7 billion. About 1050 MW of power generating capacity, constituting approximately seven percent of total power capacity addition, was contributed by non-conventional energy sources during the eighth five year plan (1992-97). The eighth plan laid emphasis on the operational programmes of biogas, low-grade solar thermal devices, improved cookstoves and other sources for meeting the energy needs especially of the rural areas.

Policy and Planning

The evolution of energy policy and planning in chronological order starting from first five-year plan (1951-56) is tabulated below.

Five Year Plans	Focus
1951-56	Priority was for agricultural development, including irrigation and power.
1957-61	Long-range investment plans for sectors like power and transport.
1962-66	Comprehensive review of extent and quality of the information available in respect to country's natural resources. A unit for natural resources was set up under Planning Commission to study problems related to assessment and development of natural resources. Broad study of trends in energy demand and supply in the country was undertaken in 1963-65 by the Energy Survey of India Committee.
1974-79	Time bound programme of action in order to achieve self-reliance in food and energy. Fuel Policy Committee was set up in 1974 to explore availability of indigenous fuel resources especially oil and gas to overcome steep price rise in 1973. Working Group on Energy Policy was set up in 1979 to suggest long-term views and action plans to optimise energy use. The Group suggested R& D in various sector to solve problems of energy sector relating to availability and efficient use.
1980-85	First time the plan envisaged a comprehensive and integrated energy strategy for the country. The plan recommended – accelerated exploitation of domestic energy resources, management of oil demand, energy conservation, exploitation of renewable sources of energy and R&D in emerging energy technologies. Inter-ministerial working group and advisory board on energy was constituted to formulate subsidy and cross subsidy for different fuels and biomass based technologies.
1986-91	Major objective of this plan was to increase use of indigenous coal and increase the share of electricity in rail transport in order to reduce dependence on oil. The plan also stressed on the need to develop and accelerate utilisation of renewable energy sources wherever these were feasible. The stress was also on design and implementation of area based rural energy programmes. The seventh plan for the first time addressed environmental degradation resulting from deforestation. Energy sector reforms initiated in 1991vide Industrial Policy Resolution to promote private sector participation in energy sector programmes.
1992-97	Reducing energy intensity in different sectors through changes in technology and processes, optimisation of inter- and intra-fuel substitution, maximising use of renewable sources of energy at affordable cost to low income groups in rural and urban areas, better demand management and development of hydel power. Minimise adverse environmental impacts associated with coal mining and associated processes. Better environmental monitoring of coal mining area and development of environmental preservation schemes.
1997-2002	Rationalising the tariff structure for energy products. Dismantling administrative pricing mechanism (ADM). Improving energy efficiency according to socio-economic and environmental priorities. Promoting renewable and environmentally sound energy systems. Promoting energy efficiency and emission standards to reduce adverse environmental impacts.

Limitations of Energy Policies

Energy policies under various five-year plans shows that till the sixth five-year plan, environmental concerns were reflected only by reference to conservation of fuel resources and their optimum utilisation. It was in the seventh five-year plan (1986-91) that concerns for environmental degradation due to deforestation were raised. At present, integration of environmental policies has taken place to some extent especially in project formulation stages in the energy and transport sectors. Measures such as requirement of environmental clearance for infrastructure projects, setting of emission norms for thermal power stations. - both coal-based and gas-based, and utilisation of low-yield ores in the mining sector are efforts to the decrease adverse environmental impacts of these sectors. It is, however, clear from the environmental monitoring data that these measures are not sufficient in arresting the increase in pollution levels. A review of existing energy policies in the country reveals that these policies have inherent lacunae in project formulation and planning, which result in environmental degradation. These lacunae are discussed below.

- Despite the requirement by the MoEF that projects related to power, oil and gas exploration, and refining and hydro power development in energy sector and road infrastructure development in transport sector submit an environmental impact statement (EIS) for obtaining clearance, the utilities have not yet fully realised the seriousness of the problem. The steps outlined for controlling emissions are usually sketchy, resulting in delays in sanction/clearance of the project. Further, lack of transparency during project formulation, impact assessment, and project development lead to stiff resistance from environmentalist and general public resulting in unwarranted delays and cost-overruns.
- The prevalence of extensive energy subsidy acts as a disincentive to the promotion and development of energy efficiency and developing energy-efficient technologies. Particularly, pricing in power and oil sector results in excessive and indiscriminate use of these resources. Often the targeted sections of the society are unable to avail the subsidy, the benefits of which go to the richer strata of the society. This results in increasing demand and, as a result, increasing emission from combustion of fuel.
- The poor financial conditions of the state electricity boards in power sector makes it difficult to invest in new plants and maintain existing plants. Scarce resources lead to the neglect of environmental control equipment, which is not essential to plant operation.
- The lack of clear cut financial incentives has resulted in a lack of interest/ motivation in adopting cleaner/more energy efficient technologies which would result into saving fuel, cutting down the emission and reducing the pollution control costs.

Matrix for the energy sector

Analysis of existing sectoral policy was carried out to determine effectiveness of existing policies in the energy sector. Following matrix presents major environmental issues associated with energy sector and identifies interventions to minimise/remove these impacts.

Sector	Activity / Subsector	Problem/Issue	Cause/ Existing Policy	Review of policy	Recommendati
Coal	▪ Mining	▪ Land degradation due to indiscriminate mining	▪ Increased coal based power generation and increased share of open cast mining due to short gestation period ▪ No mechanism to ensure land reclamation		▪ Include reclamation security in contracts for mining projec ▪ Need for policy/rules as other countrie ▪ Need for adeq mechanisms t ensure land reclamation f new mining projects and r for phased reclamation o old mines
Coal	• Utilisation	• Particulate emissions from coal based power plants • Problem of fly ash disposal	• Mandatory to install ESPs in all coal based power plants • Government directives on management of fly-ash from coal-based plants • Fiscal incentives to encourage the use of fly-ash	• Stated emissions are generally within prescribed limits, but may be higher from time to time due to poor maintenance • No incentive to further decrease emissions below prescribed standards • Utilisation is low due to lax enforcement of present environmental standards • Lack of awareness regarding the use of fly-ash as an alternative raw-material and technological constraints	• Strict enforcem and penalties • Random chec monitoring • Incentives rela to performanc slabs • Adoption and upgradation o clean –coal technologies n to be promote • Stringent enforcement o environmenta standards • Incentives to promote fly as an alternative material • More researc needed in establishing c savings in use ash over convention material
Power	• Fuel mix	• Continued dependence on coal therefore low efficiency of	▪ Coal based power generation encouraged ▪ Initiation of	• DSM inadequately addressed • Inadequate private sector	• Willingness t studies • Reforms nee accelerate pr sector partici

Sector	Activity / Subsector	Problem/Issue	Cause/ Existing Policy	Review of policy	Recommendations
		these plants • High T&D losses in power supply ▪ Uneconomic pricing • Inefficient generation, delivery and use of power ▪ Indigenous fuel supply limitations • High auxiliary consumption	power sector reforms	participation in generation, transmission and distribution	at all stages from exploration of resources to distribution of power. • Promote the use of LNG • Provide appropriate incentives and subsidies to renewable energy technologies for power generation ▪ Define role of regulator in the sector ▪ Promote cogeneration ▪ Energy prices to reflect true costs of supply
Hydro power		• Resettlement • Land degradation • Loss of forest and wildlife habitats • Loss of aquatic resources	•	• Reports on EIA do not adequately address environmental concerns.	• Mapping of areas in the country with hydro power potential • EIA need to be more rigorous and transparent ▪ Public participation at the planning stage itself
Hydrocarbons	▪ E&P ▪ Refining	• Natural gas reserves are under-exploited ▪ Operational inefficiencies in PSUs	▪ Increasing dependence on import of oil and petroleum products		▪ Increase indigenous production of oil & gas ▪ Encourage private sector investments in pipeline infrastructure ▪ Improvement in efficiency standards ▪ Facilitate technology transfer ▪ Need for regulatory body ▪ Encourage the use of gas & associated liquids as feedstocks for the fertiliser & petrochemical industries
Domestic sector	Traditional energy sources (fuelwood, dung & crop residue)	▪ Degradation of forests and indiscriminate felling of trees ▪ High levels of indoor air pollution affecting health of	• No policy explicitly directed towards indoor air pollution • National Biogas and improved	▪ Lack of access & affordability to commercial energy continues in rural areas	▪ Develop liquid and gaseous fuels based on biomass ▪ Improved productivity of forests ▪ Develop and disseminate improved chulahs

Sector	**Activity / Subsector**	**Problem/Issue**	**Cause/ Existing Policy**	**Review of policy**	**Recommendations**
		women & children in particular	stove programes aimed at DSM		and efficient devices that reduce indoor air pollution ▪ Direct subsidies to specific target groups ▪ Ensure reliable energy supply to remote areas
Environment	• Air and water	• High level of emissions/effluents	• Monitoring at source is usually done by generators • CPCB & state pollution control boards have set standards & conduct regular monitoring	• Regulatory body to be strengthened for better enforcement of regulations • Lack of economic incentives prevent polluters from adopting cleaner technologies	• Need to create national data bank on different aspects of pollution • Need for more cross checks by regulators • Economic incentives for adoption of cleane technologies • Comprehensive environment impact assessme • Conduct checks polluting units ▪ Strict legal action to be taken again polluting units ▪ Set emission level standards rather than ambient air quality standards
Industry and commercial sectors		▪ Adequate and reliable electricity supply not ensured ▪ Pollution due to use of diesel generators ▪ Scarcity & high cost of energy efficient products		▪ Lack of commitment to DSM programs ▪ Government reluctant to entrust the utilities with DSM	▪ Ensure reliable and adequate supply of grid power ▪ Energy pricing should be market driven ▪ Phase out subsidies

International Experience on Interventions in Energy Sector

The use of environmental taxes and charges in OECD countries has increased by over 50% between 1987 and 1994 While revenue raised by environmental taxes and charges remain small relative to overall taxation, they comprise a rising proportion in most European countries Among the EU member sates, the use of economic instruments has been particularly wide in the Benelux and the Scandinavian countries, and also to some extent in larger European countries such the UK, France, Italy and Germany. The transitional economies, such as Poland, Hungary and Estonia, environmental charges and taxes, despite many implementation problems, are seen as a promising mechanism to integrate economic and environmental policies. In Asian economies with rapid industrialisation, such as Taiwan, Korea, Malaysia, Thailand and Singapore, market-based instruments have over the last 5 years become frequently applied alongside the traditional command-and-control regulations still prevailing in these countries. The experiences of developed countries are discussed below.

1. Fiscal instruments
   - Emission charges are imposed in France for SO_2, out of which 90% charge revenues are returned to tax payers as subsidy for investment for pollution control system and the rest is used for development of technology.
   - Effluent charges are imposed in France, the Netherlands and Germany for all fresh and seawater polluters. Water pollution charges in Germany, with a close link to direct regulation, have effective charges linked to the degree of compliance with standards. In the Netherlands, large polluters are monitored and charged accordingly. This system has been effective not only in generating revenues but also in creating significant incentive impacts, by inducing behavioural and technological changes in industries like chemical, food, beverages and tobacco. The key for its success in France is its gradual introduction of effluent charges at low level and on few pollutants and progressive escalation to higher level with wider scope.
   - Belgium has imposed waste charges, depending on type and treatment before dumping of industrial wastes, while exempting recycled waste. The Netherlands has imposed a progressive charge on surplus manure from waste treatment.

2. Subsidies

   Most OECD countries, except UK and Australia, have provided financial assistance for environmental investments by private sector in the form of grants, soft loans, and tax allowances. These are financed from charges, revolving funds and general budget. In France, the environmental investments have close links to the charge system, and 90% of the revenue goes back as subsidy. In Germany, subsidies are financed from the general budget with the motive to assist small firms.

3. Renewables

   US, Germany and Japan have launched 'solar roof programmes' which are aimed to reduce the burden of purchasing PV systems and to create an initial market so that solar cell manufacturers may be able to decrease the prices through mass production. The fiscal measures provided include tax exemption/reduction on renewable energy system products, subsidies for new manufacturing plants, etc. in addition, US, Germany and Denmark have various tax credits including production tax credit (based on actual electricity generated), property tax deductions, accelerated deprecations, direct production incentives, subsidised government loans, etc. for wind energy development.

Review of Transport Sector Policies and Planning

Impact of Transport Sector on Environment

Increasing transport demand and consequent demand for fossil fuels have led to increasing emissions from the transport sector. The major pollutants from this sector are carbon monoxide and oxides of nitrogen. Petrol-driven vehicles are the major source of carbon monoxide emission contributing over 85% of the total transport emissions, while diesel-driven vehicles contribute over 90% of emission of oxides of nitrogen from transport sector. Emission levels of hydrocarbon and carbon monoxide from the large two- and three-wheeler population are also very high. The estimated daily pollution load generated from vehicles for four metropolitan cities in India is shown in Table 1 below.

Table 1. Estimated Emission of Pollutants from Vehicles in Metropolitan Cities (1995)

City	Amount of Pollutant (tonnes per day)				
	SPM	SO_2	NO_x	HC	CO
Delhi	10.3	9.0	126.5	249.6	651.0
Mumbai	5.6	4.0	70.8	108.2	469.0
Calcutta	3.3	3.7	54.7	43.9	188.2
Chennai	2.3	2.0	28.2	50.5	143.2

Source CPCB (1995)

Decision Tree Analysis

The Decision tree to study the transport sector's energy linkages with the environment is presented in Figure 9. Determinants of demand in the transport sector are essentially the same as for the energy sector, though the emphasis varies.

Drivers of transport demand

The most important factors driving the demand for passenger transport are the level of urbanisation and per capita incomes. Economic growth, particularly the growth of output in the industrial and agricultural sectors determines the demand for freight transport. These demands and available infrastructure in turn determine the distribution between modes of transport, road, rail, water and air.

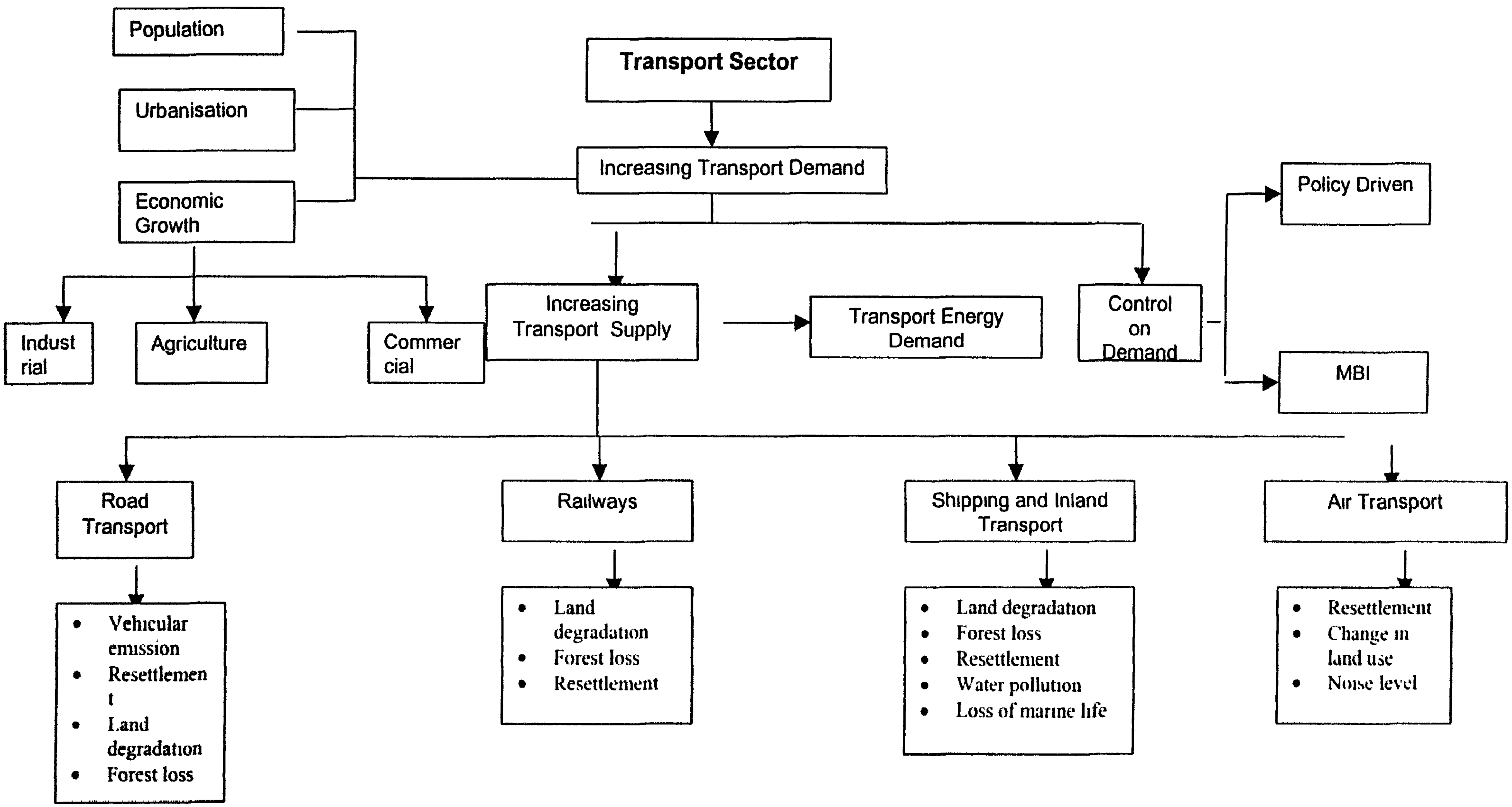
Options to meet transport demand

Increasing transport demand can be met by increasing transport supply and by constraining demand through the use of policy. Some policy options that could be introduced include the integration of land use pattern with transport planning to ensure proximity of transport corridors to habitation. An example of such integration is the concept of a 'multinucleated city' where multiple growth centres (central business districts) are developed. This results in the development of largely self–sufficient units with requisite urban amenities (commercial and business) and infrastructure. This reduces the distance between work and home by decentralising activities from a single business centre/nucleus. In turn this reduces the number of trips and trip lengths, thereby reducing emissions from the transport sector. Such policy integration combined with the introduction of market based instruments like congestion charges, parking charges and vehicle taxes can be used to control emissions from this sector.

Environmental impacts

Transportation through means of road, rail, air and coastal shipping has an impact on the environment in many forms. These environmental impacts are as given in Figure 9. Road transport in particular is associated with visible deterioration in environmental air quality through vehicular emissions. Marine pollution due to oil spills during transportation of petroleum products or tanker collisions is another environmental impact arising in this sector. Further, the construction of roads and railways to the extent that they displace local populations can lead to the social stress of resettlement.

Figure 9. Decision Tree for Transport Sector



Organisational overview

Roads, Railways, Civil Aviation, Ports, Shipping and Inland water transport comprise the transport sector in India. A number of organisations and institutions are responsible for the transport sector at the national level. The organisations, their functions and the acts relevant for the transport sector are given in the Box 5.

Box 5: Organisations in Transport Sector at the National level

Organisations	Functions	Relevant acts
Roads		
Ministry of Surface Transport	• Development of transport infrastructure – road transport	Motor Vehicles Act 1988 , the Motor Vehicle Rules 1989
National Highway Authority of India	• Development and maintenance of highways in the country	National Highways Act 1995
Ports, Shipping and inland water transport		
Ministry of Surface Transport	• Co-ordination of various activities related to ports, shipping and inland water transport	
National Shipping Broad	• Advisory body to the Ministry	Merchant shipping Act,1958
Inland Water Way Authority of India	• Regulation and development of Inland water ways for the purposes of shipping and navigation	Inland Waterways Authority of India Act, 1985
Ports Trusts	• Managing daily activities of the individual major ports in the country	Major Ports Trust Act,1963
Civil Aviation		
Ministry of Civil Aviation	• Planning and development of infrastructure for regulating air traffic. Responsible for Airport Authority of India, Director General of Civil Aviation and Bureau of Civil Aviation Security	Air Corporation Act (1953)
Airport Authority of India (AAI)	• Infrastructure and facility for Air traffic is provided by AAI. It is also responsible for maintaining domestic and international airports and civil enclaves at defence airports in country.	Airport Authority of India act (1995)
Director General of Civil Aviation/Bureau of Civil Aviation Security	• Perform regulatory functions.	
Railways		
Ministry of Railways	• Planning and development of railway infrastructure.	• Railway Act (1989)

Urban transport and environment

The transport-environment linkage is especially important in the urban context. Thus the focus of the strategies and interventions suggested is on reducing urban air pollution due to the transport sector. This linkage is elaborated in Figure 10.

Limitations of transport policies

While the rapid rate of urbanisation in India has resulted in a swift increase in travel demand, it has not been accompanied with a corresponding increase in the supporting infrastructure, including urban transport systems. The urban transport policy presently has not addressed the following issues, which has resulted in higher emissions from the transport sector (Refer Figure 10).

Inadequate public transport

Rapid increase in urban travel demand has been accompanied by an inadequate supply of public transport. In none of the major cities of India does the share of public transport in travel demand exceed 55%. This has resulted in an increasing number of personalised vehicles on roads and a higher rate of utilisation of these vehicles. This trend is typified by Delhi where the vehicle population has grown by over nine times in the period 1985 to 1995 (Bose 1999).

Poor traffic management and limited road space

Transportation infrastructure has been the primary bottleneck of unimpeded growth of this sector. Firstly, road space in the city cannot be augmented at the same rate as vehicle population. Secondly, transport management in developing countries has been characterised by poor integration of transport and land use planning. Thus the existing travel pattern of the city, emanating from the existing land use patterns, and then reinforced by accepted transport management solutions has given rise to the traffic congestion. This inefficient workplace-residence relationship and high activity level characterise all our major cities. The rapid increases in vehicle traffic and poor planning have combined to increase traffic congestion on the city roads and thus increasing journey times. The result is higher fuel consumption by a larger vehicle fleet and consequently greater emission loading from the transportation sector in the city

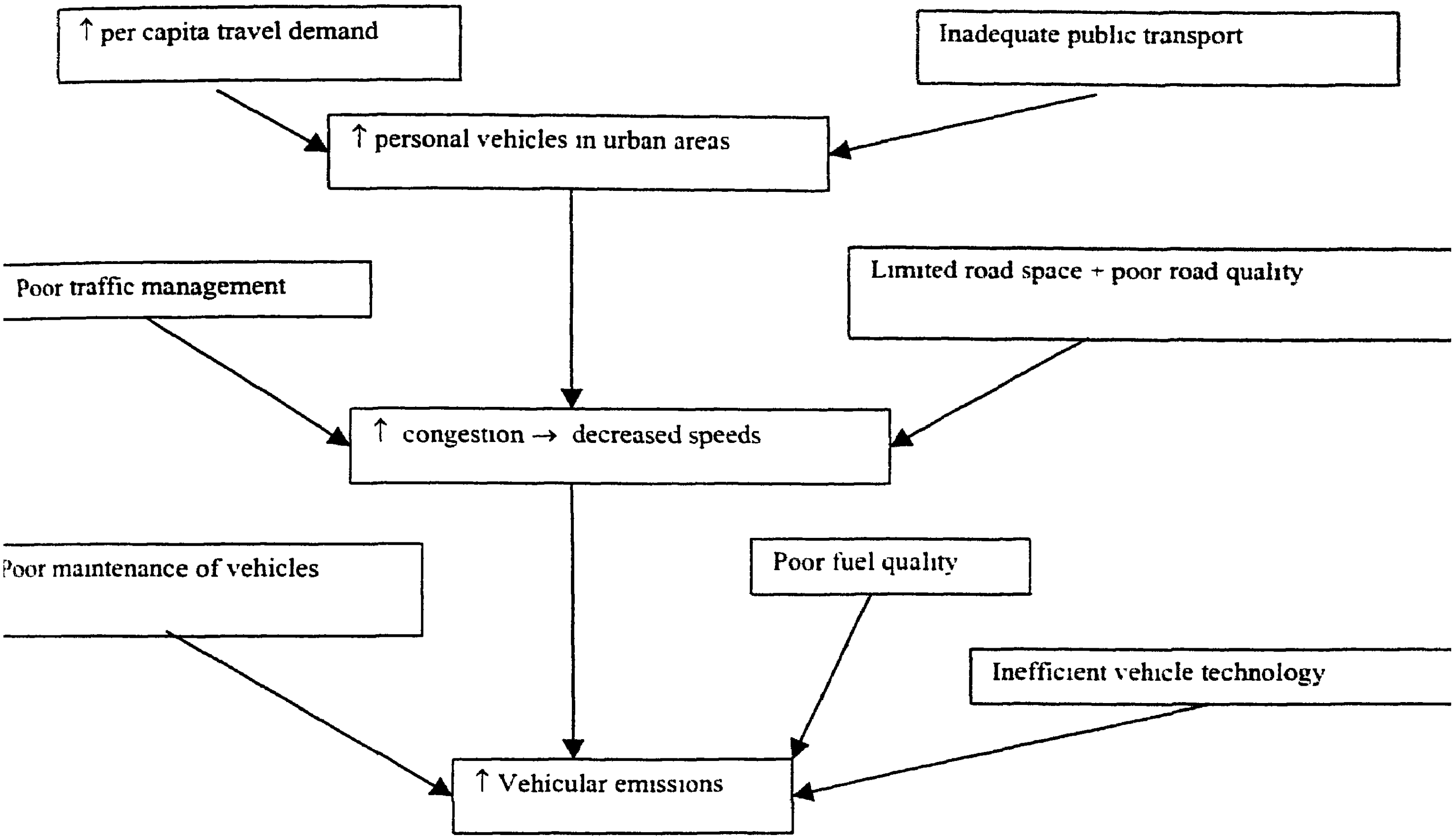
Poor fuel quality

High sulphur and lead content in diesel and petrol respectively have resulted in higher emissions. Subsidised kerosene meant for the public distribution system results in it being diverted to the black market. This inexpensive kerosene is used for adulteration of diesel or petrol leading to more pollution. The dismal quality of fuels used and their adulteration resulting in pollutants like Nitrogen Oxides (NO_X), Lead (Pb), Volatile Organic Compounds (VOCs), and Sulphur Dioxide (SO_2) have only accentuated this problem.

Inefficient vehicular technology and poor maintenance of in-use vehicles

The poor condition of the existing vehicle fleet and unavailability of efficient vehicular technology have led to greater emissions from this sector. The presence of outdated vehicular technology such as a 2 Stroke engine coupled with poor maintenance of inuse vehicles together have lead to increase in emissions from the transport sector.

Figure 10. Urban transport and environment


↑ per capita travel demand
Inadequate public transport
↑ personal vehicles in urban areas
Poor traffic management
Limited road space + poor road quality
↑ congestion → decreased speeds
Poor maintenance of vehicles
Poor fuel quality
Inefficient vehicle technology
↑ Vehicular emissions

Matrix for Transport Sector

Analysis of existing sectoral policies was carried out to determine effectiveness of existing policies in the transport sector. The following matrix presents major environmental issues associated with transport sector and identifies interventions to minimise/remove these impacts.

Major Environmental Issue	**Existing Policy**	**Effectiveness**	**Policy Needs**
Increased use of petroleum products	• Petrol-diesel price differential • Subsidised kerosene for Public Distribution System	• Increased usage of diesel resulting in higher SPM • Subsidised kerosene used to adulterate diesel and petrol leading to more pollution	• Petrol-diesel price differential need to be rationalised • Kerosene prices need to be rationalised

Increase in Vehicular emission	• Emission standards in place • Mass transit being promoted • Clean fuel alternatives like CNG, LPG, etc being explored	• Ineffective enforcement of standards • Mass transit still a bottleneck in most cities ▪ The technologies (After treatment emission control devices) available are not effective for reducing emissions	• Stricter enforcement of standards • Inspection and maintenance programme for in-use vehicles • Development of mass transport • Discouraging private modes of transport • Better traffic management on existing road network • Upgradation of road network • Promotion of cleaner fuels through Market based incentives such as differential pricing and easier access to enabling technology (such as retrofitting) • Additional field trials are necessary for verifying the effectiveness of the alternative fuels in reducing emissions

International Experience of Interventions in Transport Sector

Inspection and maintenance of in-use vehicles

The case of mandatory an inspection and certification programme for in-use vehicles is supported by the experience of countries like Germany, Japan, USA and UK and British Colombia among several others. The emission reductions from such a strategy have been established to be substantial.

In 1993 a study entitled "Pollution control of motor vehicles by introducing effective maintenance/repair work" conducted within the framework of Kathmandu Valley vehicula emission control project suggested that in Kathmandu, with minor repairs, the smoke level could be reduced by 20% to 50% (Gronskei 1996). The province of British Columbia in Canada launched a similar programme in the year 1992 in the Lower Frase Valley. The programme known as Air Care programme used state of art inspection procedure. Tests were conducted for CO, HC and NO_x. It was found that repairs following the tests reduced emissions significantly as indicated in the Table 3 below.

Table 3: Impact of Maintenance and Repairs on Emissions from In-use Vehicles

	CO (g/km)		HC (g/km)		NO_x (g/km)	
Model Year	Before repair	After repair	Before repair	After repair	Before repair	After repair
Pre – 1981	33	17	3.5	1.9	3.3	1.4
1981-1987	29	12	2.2	1.2	2.8	2.1
Post 1987	8 6	2.9	0.49	0.24	3.0	1.7

Source Radian, 1994 "Audit Results AirCare I/M Program", Report prepared for British Columbia Ministry of Environment Lands and Parks and BC Ministry of Transportation and Highways, Canada

Introducing vehicles to meet new emission standards

The introduction of progressively stringent norms in new motor vehicles worldwide has led to the production of new fuel-efficient car technologies with advancement of engine design and improved chassis structure. This has had a positive impact on emissions. For instance, emissions standards for diesel vehicles in Europe have been increased for stringency more than 7 times. This has resulted in introduction of electronic fuel injection system requiring three-way catalyst to meet the CO, NOx and HC emission standards.

Retrofitting motor vehicles to other kinds of fuel modifications

Various alternate fuels have been experimented with in various parts of the world. The City of Seattle has been using alternative fuels (primarily natural gas, and battery-operated vehicles) in their fleet since 1992. France has converted the majority of their delivery trucks to propane fuelled vehicle and have seen a reduced maintenance cost and insurance liability cost. The propane vehicles in the France fleet have approximately 10 percent lower maintenance costs than comparable gasoline-powered vehicles. In USA, Pierce Transit is considered to be the amongst the best public transport service providers with regards to using alternative fuelled vehicles. They began using CNG in 1986 and found that operating costs were lower for CNG buses. In Cairo some 11,000 people, almost all taxi drivers have converted their engines to work with inexpensive natural gas since January 1996 under a government-sponsored project. The lure is high savings rather than environmental concern as natural gas is half the price of gasoline. Today, Egypt (11,000) stands at number 8 among 47 countries using natural gas vehicles. Argentina is at the top, with more than 400,000 gas vehicles. Other top users are Italy (290,000), Russia (205,000), United States (60,000), New Zealand (25,000), Canada (17,220), and Brazil (14,000) (Source: NREL 1996).

Use of market based instruments to raise the cost of private travel

Fuel taxation has been used as a means to promote more sustainable travel in Philippines. It is estimated that using fuel taxes to tackle transport emissions could yield upwards of US $ 200 million per annum.

Mass transport alternatives

Augmentation of public transport has been a preferred policy in all over South Asia. Trolley buses are operated in Kathmandu. They are electrically powered and do not emit exhaust pollutants. It is proposed to expand this system for universal availability of public transport (Gronskei 1996). In Karachi, private sector buses and mini buses carry around

95% of the total public transport trips. The demand for transport in Karachi has not been matched by sufficient investment in infrastructure and services. Thus, the government in Karachi plans to introduce a mass transit service comprising bus ways and possibly Light Rail Transit (LRT).

Better traffic management

To achieve better traffic management, restraint on use of private vehicles and encouraging public transport have been some of the important steps taken elsewhere in other countries. Area licensing schemes have been successfully adopted in Singapore, Bangkok, and Mexico City, where problems of congestion were common in same areas. To restrain the use of private vehicles, the government in Singapore put a charge on the use of entry of low occupancy private cars in the CBD area of Singapore. A parking space was also provided for the car users who can park their vehicle outside the city centre and use shuttle bus service to travel inside the city centre. This resulted in a 20 percent increase in traffic speeds within the restricted zone and a 25 percent reduction in accidents (World Bank 1995).

Curitiba has succeeded in encouraging an important modal orientation towards the bus. Buses have priority and drive at high speeds on avenues with the help of reserved central corridors connected with tubes for safe boarding and alighting of passengers. According to the Bonilha Institute based in this region, this has resulted in lower gasoline consumption, which is 25% lower than in other similar Brazilian cities. The public transport system is directly responsible for the relatively low pollution levels registered in Curitiba despite the use of buses running with diesel motors (Bekir, 1998).

Integrated land-use planning

The city of Curitiba, Brazil has integrated sustainable transport considerations into all of its plans for development of the city. The Master Plan has ensured linear development of the city, reducing the traditional importance of the downtown area as the primary focus of all transport activity, thereby minimising congestion. The plan called for the integration of traffic management, transportation, and land-use planning to achieve its goals. The Master Plan also proposed the creation of the Institute of Urban Research and Planning of Curitiba (IURPC) to co-ordinate, modify, and oversee Plan implementation. Thus, residential development focuses along the arteries, with essential services such as water, sewage, power, telephones, and public transportation provided. Further the residential development occurs in close proximity of bus routes.

Review of Environmental Policies in India

Environmental Policies in India

Organisational Structure of Environmental Sector in India

The organisational structure of environmental sector in India is presented in Figure 11. The Ministry of Environment and Forests and the Pollution Control Boards form the regulatory and administrative core of this sector. The MoEF is the apex administrative body responsible for regulating and ensuring environmental protection in the country. The responsibility for enforcement of key environmental acts and rules lies with the respective State Pollution Control Board (SPCB). The CPCB on the other hand, has the mandate to advise the central government, co-ordinate the activities of SPCBs, and to provide them with technical assistance. Table 2 below presents select environmental legislation in India.

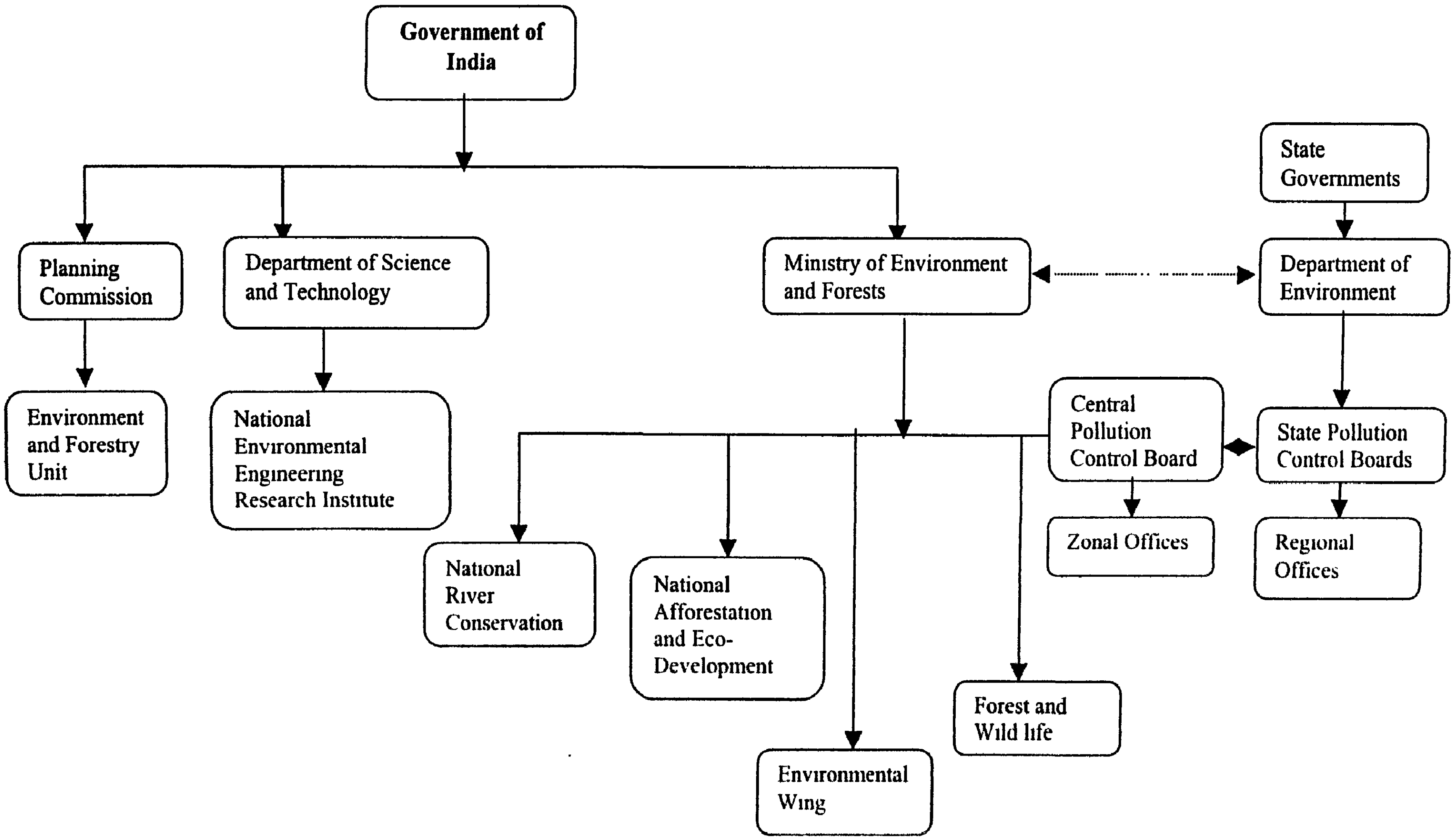
Table 2. Select Environmental Legislation in India

Year	Environmental Legislation
1972	Wild Life (Protection) Act
1974	Water (Prevention and Control of Pollution) Act
1975	Water (Prevention and Control of Pollution) Rules
1977	Water (Prevention and Control of Pollution) Cess Act
1978	Water (Prevention and Control of Pollution) Cess Rules
1980	Forest (Conservation) Act
1981	Forest (Conservation) Rules
1981	Air (Prevention and Control of Pollution) Act
1982-83	Air (Prevention and Control of Pollution) Rules
1986	Environment (Protection) Act
1988	Environment (Protection) Rules
1989	Hazardous Wastes (Management and Handling) Rules
1989/94	Manufacture, Storage and Import of Hazardous Chemical Rules/ Amendment Rules
1989	Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms, Genetically Engineered Micro-organisms or Cells Rules
1991	Public Liability Insurance Act
1991	Public Liability Insurance Rules
1992/93	Environmental (Protection) Rules – Environmental Statement
1993	Environmental (Protection) Rules – Environmental Standards
1994	Environmental (Protection) Rules – Environmental Clearance
1995	National Environmental Tribunal Act
1996	Environmental (Protection) Rules – Environmental Standards
1997	National Environmental Appellate Authority Act
1998	Biomedical Waste (Management and Handling) Rules

In addition, the Central Pollution Control Board has developed Minimal National Standards (MINAS) for most polluting industrial sectors in India. Other initiatives taken by the government for reducing industrial pollution include (1) identification of cleaner technologies/processes, (2) setting up of common effluent treatment plants (CETPs) for small scale industry clusters, (3) implementation of eco-mark scheme for environmentally friendly products, (4) preparation of zoning atlas at district levels to guide environmentally sound locations for industries, (5) Action Plans for 17 categories of major polluting industries, (6) Action Plans for 141 polluted river stretches to improve river water quality, and (7) identification of 24 critically polluted areas for pollution abatement and improving environment.

At the international level, India is a signatory to Montreal Protocol on ozone depleting substances (along with its London amendment) and Basel Convention for control of trans-boundary movement and disposal of hazardous wastes as well as United Nations Framework Convention on Climate Change.

Figure 11. The Organisation of Environmental Sector in India


Government of India
State Governments
Planning Commission
Department of Science and Technology
Ministry of Environment and Forests
Department of Environment
Environment and Forestry Unit
National Environmental Engineering Research Institute
Central Pollution Control Board
State Pollution Control Boards
Zonal Offices
Regional Offices
National River Conservation
National Afforestation and Eco-Development
Forest and Wild life
Environmental Wing

Environmental Policies in Energy Sector

All power stations (as do other sectors of the economy) have to submit Environmental Impact Statements (EIS) to the MoEF to obtain clearance for power projects. These statements give information on the steps taken to maintain emission levels in the case of thermal and nuclear stations, and regarding protection of the environment and resettlement and rehabilitation of the population in the catchment areas for hydro power stations. Right of way clearance has to be obtained for transmission lines passing through forests.

In 1986, CPCB formulated a legislation that specifies the emission standards for thermal power stations. Moreover, MoEF has stipulated that all new coal-based power plants should indicate a plan for utilisation of the ash while submitting the Environmental Impact Assessment (EIA)/Environment Management Plan (EMP) for approval.

In response to the growing pollution from thermal power stations, the MoEF in 1998 came out with Environmental Standards for coal and liquid fuel based thermal power plants (Annex 2). Adherence to these standards is monitored by the CPCB and the respective SPCBs. In addition to emissions, problems associated with mining and quarrying are also duly addressed.

The national conservation strategy and policy statement address prevention and mitigation of environmental repercussions of mining and quarrying activities. In order to prevent and minimise adverse environmental impacts, actions must be directed to:

- Mined area rehabilitation and implementation of the environmental management plans concurrently with the ongoing mining operations to ensure adequate ecological restoration of the affected areas;
- Rehabilitation of the abandoned mined areas in a phased manner so that scarce land resources can be brought back under productive use;
- Laying down of requisite stipulation for mining leases regarding tenure, size, shape and disposition with reference to geological boundaries and other mining conditions to ensure systematic extraction of minerals along with environmental conservation;
- Emphasis on production of value added end products from mining so as to reduce indiscriminate extraction;
- Upgradation and beneficiation of minerals at the source, to the extent possible in order to ensure utilisation of low-grade mineral resources and to reduce the cost of transportation, processing and utilisation;

- Environmentally safe disposal of the by-products of mining;
- Restriction on mining and quarrying activities in sensitive areas such as hill slopes, areas of natural springs and areas rich in biological diversity;
- Discouraging selective mining of high-grade ores and recovery of associated lower-grade ores during mining; and
- Environmental impact assessment prior to selection of sites for mining and quarrying activities.

In addition, general and specific conditions for environmental clearance are also prescribed by MoEF for mining projects including the coal sector. These conditions are presented in Annex 3 of this report.

For existing gas-based power generating units the limit for NO_x is 150 parts per million (ppm) at 15 per cent excess oxygen. For new units norms as provided in Annex 2 are applicable with effect from June 1, 1999.

It has been realised that energy efficiency would not only reduce the need to create new capacity requiring mobilisation of huge resources, but will also result in substantial environmental benefits. In this light, the Energy Conservation Bill, 2000, has been introduced recently (24th February 2000) and is under consideration by the Standing Committee on Energy. The objective of this bill is to promote efficient use of energy and its conservation.

At present, the Energy Management Centre (EMC) has been making efforts for efficient use of energy and its conservation. It is proposed to merge the existing EMC and establish an authority called the Bureau of Energy Efficiency (Bureau) to effectively co-ordinate with designated consumers and agencies for efficient use of energy and its conservation. This has been done as a need was felt to provide for statutory measures t establish a statutory authority and confer upon the Central Government, State Government and the Bureau certain powers to enforce measures for efficient use of energy and its conservation. The functions and powers of the proposed Bureau are provided in Box 6.

Box 6: Functions and Powers of the Bureau

- recommend to the Central Government the norms for processes and energy consumption standards for equipments and appliances;
- recommend to the Central Government for specifying any user or class of users of energy as a designated consumer having regard to intensity or quantity of energy used by it;
- recommend to the Central Government the particulars required to be displayed on labels on the equipment or appliances and the manner of their display;
- take suitable steps to prescribe guidelines for energy conservation building codes;
- take necessary measures to create awareness and disseminate information for efficient use of energy and its conservation;
- develop testing and certification procedures and promote testing facilities for certification and testing for energy consumption of equipment and appliances;
- promote innovative financing of energy efficiency projects;
- specify qualification for the accredited energy auditors, the manner and interval of time in which the energy audit shall be conducted by such auditors;
- specify certification procedures for energy managers to be appointed by designated consumers;
- prepare educational curriculum on efficient use of energy and its conservation for educational institutions, boards, universities or autonomous bodies and co-ordinate with them for the inclusion of such curriculum in their syllabus;

Power to be conferred upon the Central Government:
- specify the norms for processes and energy consumption standards for any equipment or appliance which consumes, generates, transmits or supplies energy;
- specify equipment or appliances or class of equipment or appliances for the purposes of the proposed legislation;
- prohibit manufacture or sale or purchase of equipment or appliances which do not conform to the prescribed energy consumption standards;
- direct display of such particulars on labels of equipment or appliances
- specify, having regard to the intensity or quantity of energy consumed by any users or class of users of energy as designated consumers for the purposes of the legislation;
- prescribe legislation building codes for efficient use of energy and its conservation in the building or in building complex;
- direct any designated consumer to get energy audit conducted by any accredited energy auditor;
- direct designated consumer to appoint energy manager in charge of activities for conservation of energy;
- prescribe minimum qualifications for appointment of energy manager;
- direct any designated consumer to furnish information with regard to energy consumed and action taken on the recommendation of the accredited energy auditor;
- direct any designated consumer to prepare a scheme for efficient use of energy audits conservation and implement such scheme as may be prescribed;
- take steps to encourage preferential treatment for use of energy efficient equipment or appliances;

Power to be conferred upon the State Governments:
- amend the energy conservation building codes to suit the regional and local climatic conditions;
- direct every owner or occupier of a building or building complex being a designated consumer to comply with the energy conservation building code;
- direct any designated building consumer to get energy audit conducted by an accredited energy auditor;
- designate any agency as designated agency to co-ordinate, regulate and enforce the provisions of the proposed legislation within the state;

Environmental Policies in Transport Sector

As discussed earlier, the share of vehicular pollution in total pollution loading in urban areas is reaching serious proportions. The vehicular emission control is also increasingly gaining attention. Some of the policies initiated by the government to combat vehicular pollution in India are:

- Unleaded petrol and low sulphur diesel (0.25 sulphur content) have been introduced. Unleaded petrol was introduced in four major metropolitan cities (Delhi, Mumbai, Calcutta and Chennai) in April 1995 in addition to the supply of leaded petrol in these cities. Since September 1998, only unleaded petrol is sold in Delhi and is used even by vehicles without catalytic converters. Since September 1999 unleaded petrol has been introduced in major cities. It is proposed to introduce unleaded petrol in entire country by 1 April 2000. With respect to diesel, its sulphur content was reduced from 1% to 0.5% in 1996 and was further reduced to 0.25% for metro cities and for Taj Trapezium (area around Taj Mahal) in 1997. In September 1999, the supply of diesel with 0.05% sulphur content to Delhi and with 0.25% sulphur content to other parts of the country was commenced in addition to ordinary diesel
- Compressed Natural Gas (CNG) has been introduced as an alternative cleaner fuel in Delhi, Mumbai and Vadodara. Inadequate supply of CNG and high cost of the kit to convert petrol vehicles to CNG vehicles and limited access to distribution outlets, however, has affected its acceptance amongst the consumers.
- Emission norms for all categories of petrol and diesel vehicles have been introduced at the manufacturing stage. Mass emission standards came in force in April, 1991. These were tightened in 1996 and will again be in 2000 (see Annex 4). The central government has enacted a number of laws for the control of air pollution (which includes motor vehicle emission) that apply to all of India[1]. CPCB has also notified emission standards for diesel and petrol driven motor vehicles beginning from 1986. Mass emission standards (g/km of pollutant emitted) for new vehicles were notified on 5 February 1990 These were revised and made more stringent in 1996 and standards for the year 2000 were also announced. The standards prescribed by CPCB for vehicular emissions are presented in Annex 4.
- Pre-mixed fuel (petrol and lubricating oil) for use in two-stroke engines of two- and three-wheelers has been introduced at filling stations in Delhi and other major cities of India.

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[1] The laws regulating vehicular emissions are Environment (Protection) Act, 1986, Air (Prevention and Control of Pollution) Act, 1981(amended in 1987), Air (Prevention and Control of Pollution) Rules, 1982 and Motor Vehicles Act 1939 (amended in 1988 and 1994).

- To combat pollution due to poor maintenance of vehicle, the government in 1989 introduced certificate of fitness. These were mandatory for registration of all public and commercial vehicles and for personal vehicles older than 15 years. In addition, the Vehicle Emission Rules, 1990 require all motor vehicles to comply with notified emission standards – it is now mandatory for every motor vehicle to obtain a certificate of pollution under control (PUC) every three months. Monetary fines have been imposed for violating emission standards.
- Steps have been undertaken to check fuel adulteration by establishing independent autonomous testing centres/systems for fuel certification, including the monitoring of fuel quality at retail outlets.
- In view of growing air pollution in Delhi, the Supreme Court has created an EPA [Environmental Pollution (Protection and Control) Authority] for the National Capital Region. The EPA was asked to report directly to the Supreme Court to suggest policies for pollution abatement in the city. The Supreme Court on the recommendation of the EPCA imposed the following restrictions on the age of the vehicles and the fuel being used by this sector.
    1. Restrict plying of commercial vehicles older than 15 years from 15th October 1998.
    2. No eight year old bus to ply except on clean fuels by 31st of March, 2000
    3. Replacement of all pre-1990 taxis with new vehicles on clean fuels (like CNG) by 31st March 2000.
    4. Gradual transformation of the entire city's buses fleet into a single mode on CNG by the 31st March 2001.
    5. Financial incentives for the replacement of all post-1990 autos and taxis with new vehicles on clean fuels by 31st March 2001.
    6. Augment public transport by increasing the number of public buses to 10000 by the 1st of April 2001.

The first directive relating to the maximum permissible age of commercial vehicles has already been implemented. Efforts are now underway to ensure that the remaining directives are complied with, particularly those relating to the fuel options and the size of the public bus fleet in the city.

Review of Environmental Regulations in India

A review of major pollution control laws reveals that they are essentially "Command and Control" (CAC) in nature. Individual sources of emissions are regulated through a set of do's and don'ts, e.g., by requiring compliance with emission standards or the mandatory use of pollution control equipment, etc. In general uniform standards apply to all sources and there is no attempt to take into account differences in the cost of compliance across sources. In addition to the general limitations of CAC measures, the other shortcomings in the design of the current pollution abatement regime are (Gupta, 1999):

- In addition to mandating how much pollution is allowed, the current regime also dictates how pollution is to be abated. For instance, it is stipulated that effluent standards are to be met by using the Best Available Technology (BAT). This reduces the options available to firms to use waste minimisation measures.
- The emphasis is on the end-of-pipe treatment as opposed to pollution prevention through process changes and/or use of cleaner inputs. This tendency is exacerbated by fiscal subsidies in the current regime that encourages end-of-pipe treatment (such as concession in excise duty as well as accelerated depreciation for pollution control equipment).
- Since discharge standards are predominantly concentration based, they can be met by diluting the effluent. The move towards load based standards which would deter this tendency has been slow.
- There is no attempt to link source-specific discharge standards with ambient air quality and/or water quality standards. Much of the regulatory attention has been concentrated on enforcing source specific standards in isolation, whereas ideally these would be function of ambient air/water quality.
- The laws are all-or-nothing in nature. In other words, they do not distinguish between extent of violation of standards. Thus in contrast to system of graded non-compliance fees in China, in India fines are levied on a flat basis. In addition, there are no incentives for the firms to reduce discharges below the prescribed standards.
- The laws are too stringent in the sense that they make the violation of standards a criminal act and thus discourage legitimate economic activity

In addition to problems with the design of the environmental laws highlighted above, laws also suffer from weak implementation as discussed below.

- CPCB has no real powers to enforce environmental laws. Thus, for better or worse, monitoring and enforcement are the responsibility of the states which, on the whole, are also unable to fully meet this mandate. In addition, most small and medium enterprises (roughly 3 million) are outside the monitoring and enforcement net.
- While the Environment (Protection) Act stipulates a maximum fine of US $ 2700 for failure to comply with provision of the Act, in practice the amount of the fines levied

by the courts has been meagre and does not provide any disincentive for non-compliance with the standards.

- With respect to limited enforcement that does take place, there is excessive reliance on initial compliance (verifying that pollution control equipment is installed) as compared to continued compliance.
- The burden of proof of violation of standards is too great and monitoring procedures are too cumbersome. Also only ambient water/air quality is regularly measured, and there is little systematic information on discharges from individual sources.

Growth of Judicial Activism in Environmental Matters in India

Failure of existing legislative framework to check the degradation of environment has resulted into growth of judicial activism particularly by the Supreme Court (and to an extent by High Courts) in enforcing environmental regulation in India. There has been a spate of court orders and injunctions shutting down polluting factories, hauling up civic bodies and officials of environment departments as well as of CPCB and SPCBs. Some of the key interventions of the judiciary in India are presented below (Gupta, 1999). Much of this judicial activism has been triggered by public interest litigation (PIL), reflecting the limited capacity of the executives in managing the environment.

Interventions by Judiciary in Environment Matters

- Supreme Court (SC) orders closure of 200 tanneries in Tamil Nadu
- Uttar Pradesh Government asked by SC to name steps taken to remove polluting industries around Taj Mahal
- Dunlop India fined by SC for pollution order violation
- SC orders closure of five polluting units in Rajasthan
- SC orders closure of 35 foundries in Bengal
- Gujarat High Court orders action against Ahmedabad Electricity Company on pollution charges
- The Delhi Pollution Control Committee (DPCC) has decided to take up further action and prosecute non complying industrial units that did not have ETPs and were polluting the Yamuna river by discharging their untreated wastewater directly. The Delhi Government has also sealed 20 major automobile service stations that were found to be polluting the Yamuna river.

Integration of Environmental Concerns in Sectoral Policies

Existing environmental and transport sectors policies are to a certain extent able to identify environmental concerns but the current CAC measures are certainly no solution to an integrated approach to protecting the environment. There are certain inherent barriers as discussed in previous sections to reduce environmental impacts arising from use of fossil fuel in this sector. Accordingly, a set of interventions is required to remove these barriers. Various suggested interventions for energy and transport sectors in India are listed and discussed in following sections.

Suggested Interventions for Energy Sector

1. Adoption of rational energy pricing;
2. Efficiency improvements in energy supply;
3. DSM measures;
4. Effective implementation of pollution control measures;
5. Integrated project planning and development;
6. Internalising the cost of environmental pollution/damage in the project planning;
7. Invest in hydro power plants;
8. Augmenting the use of renewable energy technologies (RETs);
9. Creation of an environment fund; and
10. Utilisation of fly ash.

Implementation of Interventions in Energy Sector

1. Adoption of rational energy pricing

In India, energy prices continue to be administered, with the objective of pursuing certain social goals. However, non-merit subsidies to sectors such as agriculture and power have contributed significantly to the fiscal deficit and environmental degradation by encouraging inefficient use of scarce resources. For example, the availability of cheap power has created a tendency in farmers to overuse water for irrigation, which has resulted in the washing off of fertilisers applied to the soil, water logging, loss in soil fertility and groundwater depletion in some cases.

Traditional fuels such as firewood, dung and crop residue are still used by a significant section of our population to meet their energy requirements. Although the prices of kerosene and LPG are subsidised with a view to providing these fuels at affordable prices for meeting energy needs in the domestic sector, kerosene is often used for adulteration in the transport sector while commercial users often use subsidised LPG. Effective targeting of subsidies is therefore required so that the benefits can accrue to the desired sections of society.

Energy prices based on real costs of energy supply are also expected to prevent undue wastage of energy resources and encourage efficiency of energy use. There is therefore a need to educate the major energy users and the public at large about the real cost of energy produced or imported.

2. Efficiency improvements in energy supply

Improving efficiency in resource extraction/production is imperative in light of the rapid increase in energy requirements in the Indian economy. Although there have been some attempts towards opening up of the energy supply sector, there still remain some bottlenecks. In the coal sector, private investors have not been forthcoming since the blocks offered for mining are not of good quality. Moreover, clearance procedures and paperwork remains a major hindrance that private parties have to bear. It is therefore proposed that procedures for various clearances should be streamlined, and adequate steps should be taken up to attract private parties and the setting up of joint ventures.

Recent policy changes encourage pithead power generation rather than the transportation of coal over large distances since transmission of electricity is more economical than transportation of coal over the same distance. Transmission and distribution losses in India are around 23% with some states having much higher levels of losses. This is considerably more than international norms (less than 10%). Efficiencies of thermal power plants in India are also considerably lower than those in developed economies. Policies directed at improving plant efficiencies coupled with reductions in T&D losses would reduce the requirement for additional generation capacity.

According to the notification of the Ministry of Environment and Forests (September 1997), coal used at power stations located more than 1000 kms from the coal mine and that used in sensitive areas should be washed to the extent of 34% ash content. However, the supply of indigenous superior quality coal is limited, as a result of which some plants have resorted to using imported coal in the last few years. This is a disturbing trend both in terms of security of supply and the drain on foreign exchange for the country. Recently, new machines called surface miners have been introduced in a few mines of Mahanadi coalfields. Surface miners can selectively extract the coal from the surrounding extraneous matter, resulting in upgradation of coal quality during the process of mining. Increased adoption of surface miners or similar technologies for selective mining should be adopted to improve the quality of indigenous coal supplies.

Further, policies should be directed towards the adoption of clean coal technologies such as atmospheric fluidised-bed combustion, pressurised fluidised-bed combustion, integrated gasification combined cycle technology and smokeless fuel processes in order to reduce emissions.

With an aim to generate cleaner power, it may be made mandatory to include some proportion of power based on renewable technologies into the grid. However, an enabling framework addressing the technological, financial and other resource requirements needs to be formulated.

In the hydrocarbons sector, indigenous supply has not been able to keep pace with the rapidly increasing demands, necessitating large quantum of imports. Development and augmentation of port facilities is therefore crucial to enable increased handling of imports. Further, augmentation of product pipelines is important since it provides for product movement in the most efficient manner.

Existing refineries need to be technologically upgraded so as to be able to produce international quality products. Rigid standards must be prescribed and enforced at various stages of operations, such as refining of crude and handling of various petroleum products during transportation, storage and handling.

3. DSM measures

Some measures for promoting demand side management include the following:

- Promoting energy service sectors to fund and manage investments in energy efficiency and to share the savings with the users;
- Placing levies on utilities to fund energy conservation programmes;
- Requiring utilities to engage in demand reduction activities as a condition for construction permits or tariff increases; and
- Provide incentives for demand side management, such as promoting the use of energy efficient equipment by providing fiscal incentives such as excise/sales tax benefits.

4. Effective implementation of pollution control measures

Although at present there are a host of pollution control laws and emission standards for control of pollution, they remain ineffective either due to weak enforcement of laws or irregular monitoring of implementation of pollution control measures by the polluting units. Abidance by the rules can only be ensured by better enforcement of these rules by regulatory authorities. Although environmental policy has made it necessary for all polluting units such as power plants to install devices for containing emission levels within the prescribed standards, at present routine checking of efficiency and performance of pollution control equipment, by the pollution control board officials, is not carried out. During inspection of the polluting units, more emphasis is given to monitoring of emissions while checking the efficiency of pollution control devices remains ignored due to lack of standardised procedures and clear cut regulatory requirements. Emphasis therefore should also be given to routine checking of efficiency and performance of pollution control equipment. This would not only act as an early warning of systems malfunction and non-compliance but also provide adequate time for remedial measures. Equally important is the need to take stringent action against non-complying parties.

5. **Integrated project planning and development**

   Although the power plant projects need an EIA before getting sanction/clearance, sections dealing with environmental management generally lack clarity/transparency. It is observed that environmental assessments are usually done for the sake of getting the clearance for pre-decided sites in most cases. A proper integration of economic, social and environmental impacts should be done at the project formulation stage itself so that the selection of unacceptable sites can be avoided.

6. **Internalising the cost of environmental pollution/damage in project planning**

   Internalisation of environmental costs can serve as a useful mechanism in choosing and adopting sustainable energy options. The use of environmental standards coupled with market based instruments can be used to effectively change the nature of incentives and disincentives faced by the polluter in making choices among available options. For example, reclamation of 'used coal mines' can be made compulsory in order to prevent irreparable damage to the land and environment in the coal mine areas. For ensuring compliance, the applicant of a mining project may be required to deposit a reclamation security (which may be a cash or financial instrument) to cover the costs of reclaiming the exploration site. Such practices are being adopted successfully in a number of countries such as Australia, Canada, U.K. and U.S.A.

7. **Invest in hydro power plants**

   The share of hydropower has decreased to 26% at present from a level of 43% in 1970-71 (TERI: Green Budget, 2000). The rapid increase in power demand over the past couple of decades has essentially resulted in the setting up of a large number of thermal power plants, which have a relatively short gestation period. Although hydro power is associated with drawbacks such as large scale dislocation, submergence of valuable resources, elimination of forests and wildlife habitats and adverse impacts on downstream hydrology, it is realised that the more environmentally sustainable energy resources such as photovoltaics, biomass, wind and tidal energy cannot be exploited on a large scale basis in the short and medium term. Therefore, in the short term the development of hydropower is desirable both in terms of reducing the pressure on fossil fuel resources and in decreasing air pollution. Hydropower is also needed to impart necessary flexibility to the grid to meet peak energy requirements. Hydropower development should however be coupled with ecologically sensitive planning, policy and legislation.

8. Augmenting the use of RETs

MNES has estimated that 126 GW of power generation capacity is available from renewable energy sources in India. This potential can be mobilised by providing appropriate incentives and subsidies to the renewable energy sector and educating the general public on the advantages of renewable options over conventional energy sources. A number of policy directives are suggested to promote renewable energy technologies.

- Policy directions should be put in place to promote a minimum supply of renewable energy based electricity in the grid. Tariff guidelines would be provided by the CERC to SERCs for renewables, including aspects of performance incentives.
- It is proposed to develop credit-delivery infrastructure and provision of working capital for entrepreneurs. The reach of the credit mechanisms should be increased by developing appropriate partnerships with commercial banks, especially with lead banks in the rural and backward areas. Innovative approaches to link the formal credit mechanisms with micro-credit schemes and self-help groups should be encouraged to reach out to potential borrowers who are normally not exposed to the benefits of regular credit programmes.
- Provide subsidies for solar technologies and incentives such a tax benefits to individuals using renewable technologies.
- For technologies in the R&D stage, it is proposed that research grants would promote the development of prototypes with acceptable performance and reliability levels. During the commercialisation stage, policy should be directed towards the creation of demand for new products and the development of appropriate market-support infrastructure.
- Monitoring and evaluation of specific programmes should be carried out by independent agencies such as the Solar Energy Centre, the Centre for Wind Energy Technologies etc.

9. **Creation of an Environment Fund**

A part of the revenue generated through the levied environmental cesses/taxes should be used to create an Environment Fund that could be headed by the MoEF and the Ministry of Finance could manage the fund. Incentives for clean technologies may be provided through this fund.

10. **Utilisation of fly ash**

The high ash content of Indian coal makes ash disposal one of the most pressing environmental problems that India faces as a result of the high degree of reliance on coal-based energy. Implementation of measures to utilise fly ash from thermal power plants can be achieved by providing adequate incentives and inculcating awareness with regard to the use of fly ash as an alternative raw material. For example, the cost of producing clay bricks should be considered in conjunction with loss of topsoil, emission from brick kilns and degradation of the landscape. Incentives such as excise concessions could be provided for cement production using more than 10% fly ash as raw material input.

Suggested Interventions in Transport Sector

Existing environmental and transport sectors policies are to a certain extent able to identify environmental concerns but the current CAC measures are certainly no solution to an integrated approach to protecting the environment. Accordingly, a set of interventions is required to remove sections to reduce environmental impacts arising from use of fossil fuel. The lack of clear cut financial incentives has resulted in a lack of interest/ motivation in adopting cleaner/more energy efficient technologies which would result into saving fuel, cutting down the emission and reducing the pollution control costs. For instance, abatement strategies in the transportation sector have focused on mandating specific fuel and technology combinations for specific modes. Under such a regulatory structure, the abatement activity is necessarily more expensive and inefficient as incentives for cost minimising adjustments are absent.

TERI has carried out vehicular emissions projections (1997 to 2047) for city of Delhi under baseline scenario (DISHA 2000). In the baseline scenario, the total emissions in 2019 will be twice as high as those in 1997; and by 2047, they will be 6 times the amount in 1997. Therefore unless no policy intervention takes place focussing on traffic management, cleaner fuels and improved vehicular technology, the emissions from the transport sector would continue to increase. Introducing instruments focussing on three elements (fuels, vehicles and traffic management) can reduce the emissions from the urban transport sector. These interventions are discussed below.

1. Fuels

In terms of fuel quality and pollutant levels in various fuels, the regulations should focus on banning the use of highly polluting fuels and mandating fuel quality standards. Fuel prices are the most obvious contenders for raising the travel costs and thus discouraging travel by personalised modes. Increase in fuel prices would increase the cost of travel by personal modes, which would be much higher in comparison to the increase in travel cost by public transport due to a higher occupancy in the latter. However the higher fuel taxes do not significantly affect the travel demand due to low price elasticity demand for transportation fuels. These have been reported to be very low in the short run for India as well. The estimates vary from –0.21 to –0.41 (Ramanathan 1999). Hence there would also be severe inflationary impacts of fuel prices increase. Thus vehicle taxation appears to be a more appropriate medium to influence shift from private to public modes. The diesel/ petrol- kerosene price differential has leads to adulteration of fuel. Therefore by removing the price distortion between these fuels, adulteration of petrol/diesel with Kerosene can be reduced substantially

2. Vehicles

Stricter emission norms and compulsory inspection and maintenance programme are some of the instruments to not only reduce emissions from the new vehicles, but also reduce emissions from the inuse vehicles, which constitute 80% of the private vehicles on the road.

Differential vehicle taxation can be used so as to promote cleaner technologies and efficient means of transport (mass transport). The private vehicles could be charged a higher sales tax to discourage the purchase of private vehicles and thus encourage public modes of travel. An annual road tax could also be charged for vehicles that are differentiated according to the vintage so as to discourage ownership of older vehicles. The motor vehicle tax thus collected could even be used to finance the public bus fleet expansion and subsidise cleaner technologies. Sales tax waiver can be given to retrofit kits for using cleaner fuels such as CNG. This would reduce the upfront cost of the engine and encourage usage of cleaner vehicle technology using cleaner fuels.

3. Traffic management

Augmentation of public transport and giving priority to their movement has been one of the most favourable traffic management measures that has been practised elsewhere along with restraint on the use of private vehicles. To reduce urban congestion and put restraint on the indiscriminate use of private vehicles, the following instruments would have to be implemented. Market based instruments in form of congestion charges, area licensing scheme and parking charges would reduce the entry of private vehicles especially in the congested urban areas. The strategies aimed at regulating the flow of traffic and reducing congestion in general have been based on a rational pricing of road space, that is, levying congestion charges that reflect the true scarcity value of transport infrastructure. Restraint on use of private vehicles through management and engineering measures such as giving priority to movement of public transport, exclusive bus lanes and grade separation segregating fast and slow moving traffic are important elements of any abatement strategy for the transport sector.

Conclusions

From the preceding discussions it is apparent that there are significant environmental impacts arising out of operations of energy and transport sectors. Existing environmental policy integration in these sectors is not sufficient to mitigate these impacts. Considerable scope still exists to integrate environmental concerns in the policies and planning of energy and transport sectors. To integrate these environmental concerns in the sectoral policies, there are a number of interventions required – one which are CAC based and others, which are market, based. These interventions, however, cannot work independent of each other. Market base instruments would require an administrative set up to implement and enforce the tax regime. Here CAC measures like setting up emission standards for fuels and their enforcement would work well with differential price taxing between less polluting and more polluting fuels (e.g. leaded and unleaded gasoline).

In addition to these specific interventions for energy and transport sectors, adopting measures like strategic environmental assessment (SEA) and environmental management system (EMS) in the project formulation and development stage would help in identifying the adverse impacts in early stages so that timely and appropriate actions can be taken well in advance. SEA is a formalised, systematic and comprehensive process of evaluating the environmental impacts of a policy, plan or programme and its alternatives, preparation of a written report on the findings, and use of the findings in publicly-accountable decision making. Use of SEA prior to proper EIA can in certain cases obviate the needless reassessment of issues and impacts at a project level where such issues could more effectively be dealt with at a strategic level, and offer time and cost savings. In past, SEA has been used successfully in assessment procedures for sectoral programmes as well as regional programmes of agencies such as the World Bank and the Asian Development Bank.

EMS, on the other hand, is a rigorous and systematic process for identifying, and improving, the environmental performance of an organisation/system in operation on a continuous basis. The environmental effects of operations in energy and transport sectors are considerable, both through direct impacts of day-to-day operations (e.g. production, transportation and use of fuel and energy), and the indirect influences on the environment arising from decision-making and policy processes. Use of EMS in day-to-day operations of organisations engaged in energy management will help them improving their own environmental performance, which is the best way to enhance their credibility and their acceptability among the general public. In addition, use of EMS results in considerable resource saving as the focus is on minimisation and recovery/reuse. EMS should be completely integrated into planning, decision-making, and execution of actions in these sectors.

However, a host of techno-economic and political issues are associated with each of these policy interventions which can affect their implementation. In order to understand and plan for these policy interventions, pilot implementation of these measures could be considered in select region/sectors, followed by wider implementation.

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Rules and Regulation in Energy Sector

Table 1. Rules and Regulation in Power Sector

Acts/Rules/Regulations	Promulgation	Amendment	Brief Content
The Electricity Act	1910	In various years by State Government	An Act to regulate supply and use of electrical energy and to regulate the industry and protected the consumer's interests
DVC Act	1948		The provision with regard to electricity supply in Damodar Valley Corporation command area.
Electricity (Supply) Act	1948	1976, 91	Creation of State Electricity Boards and Electricity Departments for generation, transmission and distribution of electricity in different states of the country.
Atomic Energy Act	1962		Deals with nuclear power development in the country.
Electricity Regulatory Commission Act	1998		Setting up of Central Electricity Regulatory Commission to regulate tariff related matter, advice central government on formulation of tariff policy, frame guidelines pertaining to tariff and promote competition and efficiency in electricity sector

Various rules and regulation applicable to coal sector can be put into three categories:

Category 1: Rules and regulations relating to and or impacting on the ownership of minerals, the granting of rights to prospect for and exploit minerals, and right of surface access, environment, forestry, reclamation and rehabilitation and local communities.

Table 2. Rules and Regulation in Coal sub-sector (relating to impact on ownership of minerals)

Acts/Rules/Regulations	Promulgation	Amendment	Brief Content
The Mines and Minerals (Regulation and Development) Act	1957	1986	The Act provides for regulation of prospecting, grant of lease and for mining operations under the control of central government.
The Coal Bearing Areas (Acquisition and Development) Act	1957		An Act to establish, in the economic interest of India, greater public control over the coal mining industry and its development by providing for acquisition the State of unworked land containing or likely to contain coal deposits or of rights in or over such land for extinguishment or modification of such rights by accruing virtue of any agreement, lease, license or otherwise or for matters connected therewith.
Mineral Concession Rules	1960		These rules lay down the complete code in respect of grant and renewal of prospecting licenses as also for lease in respect of lands belonging to the states as well as belonging to private individuals.
The Coking Coke Mines	1971		An Act to provide for the taking over, in the

Acts/Rules/Regulations	Promulgation	Amendment	Brief Content
(Emergency Provisions) Act			public interest, of the management of coking coal mining and coke oven plants, pending nationalisation of such mines and plants.
Coking Coal Mines (Nationalisation) Act	1972		An Act to provide for the acquisition and transfer of the right, title and interest of the owner of such coke oven plants as are in and about the said coking coal mines with a view to reorganising and reconstructing such mines and plants for the purpose of protecting, conserving and promoting scientific development of the resources of coking coal needed to meet the growing requirements of iron and steel industry and for matters connected therewith or incidental thereto.
Coal Mines (Nationalisation) Act	1973		An Act to provide for the acquisition and transfer of the right, title and interest of the owner in respect of the coal mines specified in the schedule with a view to reorganising and reconstructing such coal mines so as to ensure the rational, co-ordinated and scientific development and utilisation of coal resources consistent with the growing requirements of the country, in order that the ownership and control of such resources are vested in the State and thereby so distributed as best to sub-serve the common good, and for matters connected therewith or incidental thereto.
The Coal Mines (Takeover of Management) Act	1973		An Act to provide for taking over, in the public interest, of the management of coal mines, pending nationalisation of such mines, with a view to ensuring rational and co-ordinated development of coal production and for promoting optimum utilisation of coal resources consistent with the growing requirements of the country, and for matters connected therewith or incidental thereto.
The Coal Mines (Development and Conservation) Act	1974		An Act to provide for conservation of coal and development of coal mines and for matters connected therewith or incidental thereto.
The Coal Mines (Nationalisation) Amendment Act	1993		The Act stipulates that on and from the commencement of the Coal Mines Nationalisation Act, 1976, (a) no person other then a company engaged in: • The production of iron and steel • Generation of power • Washing of coal obtained from mine or • Such other use as the Central Government may by notification specify shall carry on coal mining operation in India, in any form.

Category 2: Rules and regulations relating to impacting on labour, trade unions, compensation, safety and health in workplace, welfare outside the workplace, etc.

Table 3. Rules and Regulation in Coal sub-sector (impact on labour, trade union, etc.)

Acts/Rules/Regulations	Promulgation	Amendment	Brief Content
The Mines Act	1952	1983	The Act seeks to regulate the working conditions in mine by providing for measures to be taken for the safety of the workers employed in them and certain amenities for them.
Mines Rules	1955	1978, 1986	The Rules deal with appointment and qualification of certifying surgeons; medical examination of persons employed; appointment of workmen's Inspector; constitution of Safety Committee; provision for first aid and medical appliances; weekly day of rest; persons holding position of supervision or management; leave with wages; welfare amenities, e.g., shelter, canteen; duty of welfare officer, etc.
Coal Mines Regulations	1957	1961, 62, 63, 64, 65, 67, 68, 69, 70, 71, 72, 73, 74, 77, 78, 85 and 90	The Regulations prescribe various returns and notice to be given and records to be maintained. The regulations further lay down manner of examination for grant of various competency certificates by government; the qualification and conditions of appointment of inspectors, surveyors and engineers under and assistant managers and managers; duties and responsibilities of workmen, competen persons and officials; maintenance of plan and sections; means of access and egress transport of men and materials; mine workings; precautions against dangers from fire, dust, gas and water, ventilation, lighting, explosives and shot firing; use of machinery, plant and equipment, etc.
The Coal Mines Pithead Bath Rules	1959		Some of the provisions relate to: • Standard of construction • Quantity and quality of water • Lighting, sanitation and cleanliness • Attendants
Mines Crèche Rules	1966		These Rules prescribed the standards for crèches, including medical supplies.
Mines Vocational Training Rules	1966		The Rules lay down manner of appointment of training instructors and officers for imparting vocational training; the equipping of vocational training centre and the curriculum; the provision of trainin centres, etc.
Mines Rescue Rules	1985		It prescribes the location, size and numbe of rescue stations/rooms to be set up; appointment of competent persons, Superintendents, Instructors, and brigade members; equipment and organisation fo effective rescue/recovery work.
The Trade Union Act	1926		An Act providing for registration of unions and their rights as registered trade union
Coal Mines Provident Fund and Miscellaneous Provisions Act	1948		An Act to make provisions for the framin of the provident scheme, a family pensio scheme and bonus scheme for coal mine employees.

Category 3: Rules, regulations and order relating to and/or impacting on marketing, distribution, sales, pricing, contracts, transportation and exports/imports.

Table 4. Rules and Regulation in Coal sub-sector (impact on marketing of coal)

Acts/Rules/Regulations	Promulgation	Amendment	Brief Content
Colliery Control Order	1945		Initially issued under Defence of India Rules, 1945 and subsequently made the Essential Commodities Act. The order prescribes the role and functions of Coal Controller and deals with grading of coal and distribution of coal.

Emission Standards for Thermal and Gas Based Power Plants

Table 1. Emission Standards for Thermal Power Plants

Source	Parameter	Maximum limiting concentration (in mg/litre except for pH & temperature)
Condenser cooling water (once through cooling system)		
	pH	6.5 to 8.5
	Temperature	Not more than 5° C higher than the intake water temperature
	Free available chlorine	0.5
Boiler blowdown	Suspended solids	100
	Oil and grease	20
	Copper (Total)	1.0
	Iron (Total)	1.0
Cooling tower blowdown	Free available chlorine	0.5
	Zinc	1.0
	Chromium (Total)	0.2
	Phosphate	5.0
	Other corrosion-inhibiting material	Limit to be established on case by case basis by Central Board in case of Union territories and State boards in the case of States
Ash pond effluent	pH	6.5 to 8.5
	Suspended solids	100
	Oil and grease	20

Standards for air emissions in thermal power plants

Generation capacity	Pollutant	Emission limit
210 MW and above	Particulate matter	150 mg/Nm^3
<210 MW	- do -	350 mg/ Nm^3

Stack height limits in thermal power plants

Generation capacity	Stack height (metres)
500 MW and above	275
200 MW/210 MW and above to less than 500 MW	220
Less than 200 MW/210 MW	$H = 14 (Q)^{0.3}$ where Q is emission rate of SO_2 in kg/hr, and H is stack height in metres

Source: CPCB, 1998, Pollution Control Acts, Rules, and Notification issued thereunder.

Table 2. Emission Standards for Gas-based Power Plants

Total generation of gas turbine	Limit for Stack NO_x emission {(v/v), at 15% excess oxygen)}
400 MW and above	50 ppm for the units burning natural gas 100 ppm for the units burning naphtha
Less than 400 MW but up to 100 MW	75 ppm for the units burning natural gas 100 ppm for the units burning naphtha

Less than 100 MW	100 ppm for the units burning natural gas or naphtha as fuel
For the plants burning gas in a conventional boiler	100 ppm

Stack height limits:
Stack height (in metres) should be calculated using the formula $H = 14 Q^{0.3}$, where Q is the emission rate of SO_2 in kg/hr, subject to a minimum of 30m.

Liquid waste discharge limit:

Parameter	Maximum limiting concentration (mg/litre except for pH and temperature)
PH	6.5-8.5
Temperature	As applicable for other thermal power plants
Free available chlorine	0.5
Suspended solids	100.0
Oil and grease	20.0
Copper (Total)	1.0
Iron (Total)	1.0
Zinc	1.0
Chromium (Total)	0.2
Phosphate	5.0

Source: CPCB, 1998, Pollution Control Acts, Rules, and Notification issued thereunder.

General and Specific Conditions on Environmental Clearance of Mining Projects in India

General conditions

- No change in mining technology and scope of working should be made without prior approval of Ministry of Environment and Forests (MoEF).
- No change in calendar plan including excavation, quantum of mineral and waste/ OB dumps should be made.
- _________ambient air quality-monitoring stations should be established in the core zone as well as buffer zone for RSP, SPM, SO_2, NO_x, and CO monitoring. Location of the stations should be decided based on meteorological data, topographical features, and environmentally and ecologically sensitive targets in consultation with State Pollution Control Boards (SPCBs).
- Data on ambient air quality should be regularly submitted to the MOEF including its regional office at _________and SPCB/Central PCB once in six months.
- Fugitive dust emissions from all the sources should be controlled regularly monitored and the data recorded properly. Water spraying arrangements on the haul roads, wagon loading, dump trucks (loading and unloading) should be provided and properly maintained.
- Adequate measures should be taken for the control of noise levels below 85 dB in the work environment. Workers engaged in blasting and drilling operations, operations of HEMM, etc. should be provided with ear plugs/muffs.
- Industrial wastewater (workshop and wastewater from the mine) should be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19th May 1993 and 31st December 1993 or as amended from time to time. Oil and grease trap should be installed. The treated wastewater should be utilised plantation/dust suppression.
- Sewage treatment plant should be provided in the township, if any, for treatment of domestic effluent. The treated effluent should be utilised plantation/dust suppression
- Acid mine water, if any, has to be treated and disposed of after conforming to the standard prescribed by the competent authority.
- Garland drain of appropriate size should be constructed to collect the surface run-of from the OB and mineral dumps. The collected run-off should be collected in sedimentation tank before discharge into water body/release into drain (s). Drains should be regularly desilted and maintained properly.

- Environmental laboratory should be established with adequate number and type of pollution monitoring and analysis equipment in consultation with SPCB.
- Personnel working in dusty area should wear protective respiratory devices and they should also be provided with adequate training and information on safety and health aspects.
- Occupational health surveillance programme of the workers should be undertaken periodically to observe any contraction during exposure to dust and take corrective measures, if needed.
- A separate environmental management cell with suitable qualified personnel should be set-up under the supervision of Senior Executive, who will report directly to the head of the organisation.
- The funds earmarked for the environmental protection measures should be kept in separate account and should not be diverted for any other purpose. Year-wise expenditure should be reported to MoEF.

Specific Conditions

- Topsoil should be stacked properly with adequate measures at the earmarked site. It should be used for reclamation and rehabilitation of mined-out areas.
- OB dumps should be stacked at earmarked dump site (s) only and should not be kept active for long period. Active OB dump should be appropriately stacked and stabilised to plan for reclamation detailing measures to stabilise the dumps, monitoring and management of rehabilitated areas until the vegetation self sustaining and the funds earmarked for implementing the plans should be submitted to MoEF within six months.
- Drills should be wet operated or with dust extractors.
- Coal handling plants including the transfer points should be provided with adequate number of high efficiency dust extraction system.
- Spontaneous heating and fire in coal dumps should be controlled by proper stacking. Heating spots and fire sites should be watered continuously/regularly as necessary.
- Groundwater quality and water table should be regularly monitored and data recorded should be furnished to this Ministry and its regional office at ________ including the SPCB/CPCB once in six months.
- Project authority should ensure structural safety of the embankment proposed. They should also prepare and submit a contingency plan for safety of life and property from flash flood, if any in consultation with the concerned authorities.

- As per reclamation plan, most of the disturbed area should be reclaimed before abandoning the mine.
- Digital processing of the entire lease area using remote sensing technique should be done regularly once in every three years for monitoring landuse pattern and report should be submitted to the Ministry and its regional office.
- Regular monitoring of subsidence movements on the surface over working area and impact on water bodies/vegetation/structures/surrounding should be continued till the movement ceases completely. In case of observation of any high rate of subsidence movements, appropriate precautionary measures should be taken to avoid loss of life and material. Cracks should be effectively plugged with blast and clayey soil/suitable material.
- Excavated open pit after mining should be developed into water reservoir, where rain water can be harvested to recharge aquifer.

Annex 4

Vehicular Emission Standards and Fuel Specification for India

Table 1. Emission standards with effective date for new petrol vehicles in India under type approval test, gm/km

Vehicle type	CO				HC	HC+NO$_x$		
	1.4.1991	1.4.1996	1.4.2000 Euro I	1.4.2005[a] Euro II	1.4.1991	1.4.1996	1.4.2000 Euro I	1.4.2005[a] Euro II
2-wheelers	12-30	4.5	2	-	8-12	3.6	2	-
3-wheelers	12-30	6.75	4	-	8-12	5.4	2	-
Cars – with cc[b]	-	4.34-6.2[c]	2.72	2.2	-	1.5-2.18[b]	0.97	0.5
Cars – without cc	14.3-27.1	8.68-12.4[c]	2.72	2.2	2-2.9	3-4.36[b]	0.97	0.5

[a] Proposed.

[b] Catalytic converter.

[c] The range corresponds to the engine capacity stratified into three classes:- upto 1400 cm^3, 1400-2000 cm^3 and over 2000 cm^3.

Note:

1. Euro I is effective with effect from 1.6.1999 and Euro II will become effective with effect from 1.4.2000 for private (non-commercial) vehicles in National Captive Region (NCR).
2. The test will be as per Indian driving cycle (which simulates average driving pattern such as acceleration, cruising, deceleration, etc.) with warm start. However, with effect from 1st April 1998, the test will be as per Indian driving cycle with cold start.
3. For passenger cars not fitted with catalytic converter, the test will continue to be with warm start as per existing procedure, till 1.4.2000.
4. For vehicles fitted with catalytic converter a deterioration factor of 1.2 on Type Approval limits will be applicable for durability.
5. A 20% relaxation is given in the conformity of production standards for CO and combined HC+NO$_x$ for all category of vehicles. But, the relaxation limit is reduced to 16.5% for cars to be registered after 1st April 2000.
6. Evaporative emission should not be more than 2 gms per test.
7. There should be no crankcase emission.

Source: (Bhatnagar and Raje, 1999)

Table 2. Emission standards with effective date for new diesel vehicles in India under type approval test

Pollutant	1.4.1991	1.4.1996	1.4.2000 Euro I	1.4.2005[a] Euro II
Gross vehicle weight > 3.5 ton g/kWh				
CO	14.0	11.2	4.5	4
HC	3.5	2.4	1.1	1.1
NOx	18.0	14.4	8	7
PM for > 85 kW	-	-	0.36	0.15
PM for < 85 kW	-	-	0.61	0.15
Gross vehicle weight < 3.5 ton g/km				
CO	14.3-27.1	5-9	2.72-6.9	1.06
HC+NO$_x$	2.7-6.9	2-4	0.97-1.7	0.71
NO$_x$	-	-	-	0.566
PM	-	-	0.14-0.25	0.080

[a] Likely to be proposed.

Note:

(a) Diesel vehicles with gross vehicle weight less than equal to 3.5 ton

1. Euro I for diesel vehicles is effective with effect from 1.6.1999 and Euro II will become effective with effect from 1.4.2000 for private (non-commercial) vehicles in NCR.
2. The emission norms relate to vehicles with reference mass varying between 1 ton and over 2.15 ton.
3. The test cycle is as per 13 mode cycle on a chassis dynamometer.
4. The test should be as per Indian driving cycle with cold start.
5. A 10% relaxation is given in the conformity of production standards for CO and combined $HC+NO_x$ for all category of vehicles. But, with effect from 1st April 2000, the relaxation limit is increased from 16% to 18% for CO and NO_x combined together while that of PM from 16% to 29% depending upon the reference mass of the vehicle.
6. The vehicles fitted with catalytic converters a deterioration factor 1.1 for CO, 1.0 for $HC+NO_x$ and 1.2 for PM on type approval limits will be applicable for durability.

(b) Diesel vehicles with gross vehicle weight more than 3.5 ton

1. A 10% relaxation is given in the conformity of production standards for CO and combined $HC+NO_x$ for all category of vehicles. But, the relaxation limit is reduced to 9% for CO, 12% HC and NOx and 11% for PM with effect from 1st April 2000.

Source: (Bhatnagar and Raje, 1999)

Table 3. Gasoline specifications for India and Europe

Property	India		Europe	
	2000-2005[a]	Beyond 2005	Euro 1 & 2	Euro 3
Sulphur (%m/m)	0.1-0.05	0.02	0.05	0.015
Maximum Lead content (g/l)	0.013	0.005	0.013	0.005
Maximum Benzene content (% v/v)	5-3	2-1	5	1
Octane number				
▪ Research Octnane Number	87-91	91, 95	95 (min)	95 (min)
▪ Motor Octane Number	82	82, 85	85 (min)	85 (min)
Hydrocarbon Composition (%v/v)				
▪ Aromatics	45-40	<35	Not specified	42
▪ Olefins	30-20	20-10	Not specified	18
Distillation - E100 (%v)	50-65	50-65	40-70	40-70
Reid Vapour Pressure (kilo Pascal)	35-60	45-60	35-100	35-100
Density at 15° C (kg/m^3)	700-750	715-770	725-780	725-780

[a] Desirable to reach the level well ahead of 2005.

Table 4. Diesel specifications for India and Europe

Property	India		Europe
	2000-2005[a]	Beyond 2005	Euro 1 & 2
Sulphur (%m/m)	0.05-0.03	0.005-0.003	0.05
Cetane number	48-50	52	49
Poly Aromatic Hydrocarbon (%v/v)	<10	<5	Not available
Distillation – 95°C	370-360	360-355	370
Density at 15° C (kg/m^3)	820-860	820-850	800
Total Aromatics %	-	<25-15	Not available

[a] Desirable to reach the level well ahead of 2005.

Integration of Environmental Policies in Energy and Transport Sectors - A study for Gujarat

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An overview of the Energy Sector

Power generation

The electricity demand in the State is met through its own generation, from Gujarat Electricity Board (GEB) power plants, and power purchase from Central Generating Stations and Independent Power Producers (IPPs). The total installed capacity as on 31st March 1999 stood at 8182 MW. This includes 1293 MW of allocated share of Gujarat from central sector stations. The GEB currently has nine generating stations, of which 4 are coal based namely Ukai Thermal Power Station (TPS), Gandhinagar TPS, Wanakbori TPS and Sikka TPS. It has one lignite-based power plant in Kachchh and one liquid fuel oil (RFO) based power plant at Dhuvran (please see the energy map of Gujarat for locations). There are two hydro power stations, namely Ukai and Kadana. A relatively new gas based power plant is located at Utran. In the private sector, except for Ahmedabad Electricity Company's Sabarmati TPS (510 MW) which is a coal based station, all others are designed for gas (with the provision of utilising naphtha as a supplementary fuel whenever there is a shortfall in gas supply). The IPPs are Essar Power limited (615 MW gas based) and Gujarat Torrent Energy Corporation (615 MW gas based). The cumulative capacity of all IPPs stands at 1740 MW. The existing generation capacity by fuel type and ownership is shown in the Figures 1 and 2 below.

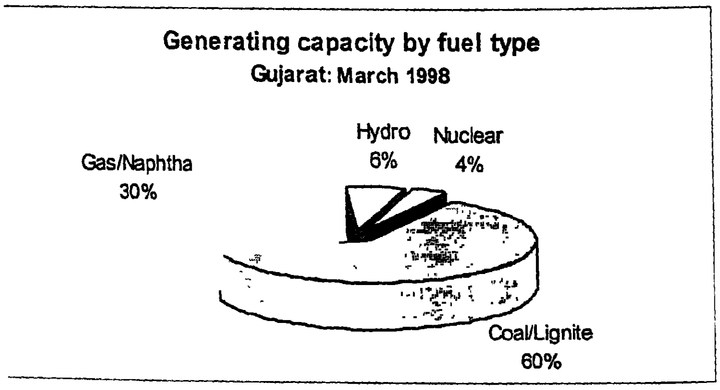

Figure 1 Gujarat generating capacity by fuel type

Source: TERI 2000

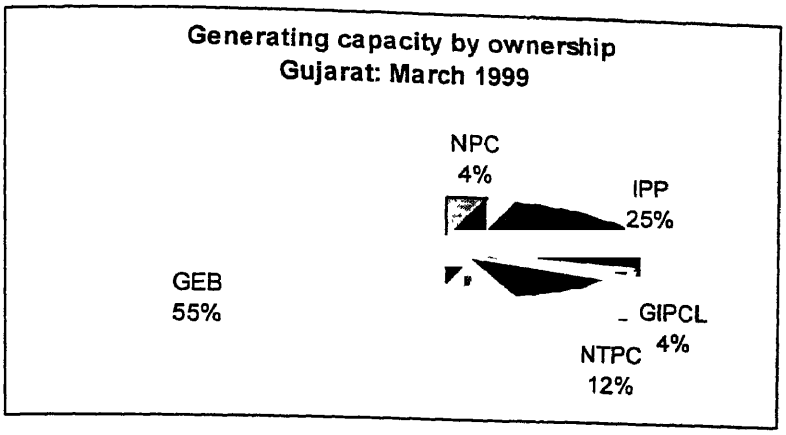

Figure 2 Gujarat generating capacity by ownership
Source: TERI 2000

Gujarat does not have any coal deposits. However, there are lignite reserves of 700 million tonnes (MMT) available at a few locations in Kachchh, Saurashtra and South Gujarat. The overall share of coal/lignite based generation is about 60%. Gas and naphtha based capacity, on the other hand has a share of 30% as compared to a mere 9% share at the all-India level. Due to scarce availability of hydro resources in Gujarat, its share in total installed capacity is merely 6%.

Lignite

Gujarat has an estimated 700 million tonnes (MMT) of lignite available at a few locations in Kachchh, Bhavnagar, Bharuch and Surat districts. With further exploration, this figure could go up to 2000 MMT. Kachchh has a deposit of around 210 MMT spread over seven fields. The Gujarat Mineral Development Corporation (GMDC) has been mining lignite at the Panandhro mine in Kachchh with reserves of 98 MMT and at Rajpardi in Bharuch with reserves of 15 MMT[2].

Oil and gas

Oil and gas production in Gujarat in the nineties have been as shown below.

Table 1 Crude oil and natural gas production in Gujarat

	1990/91	1995/96	1996/97	1997/98	1998/99
Crude oil (TMT)	6398	6362	6158	5951	5828
Natural gas (MMCM)	1696	2878	2932	3115	3166

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[2] The Panandhro mine has been worked since 1974 and about 36 MMT has been mined so far. The mine will be worked for another 20-25 years. GMDC has leased an area of about 1800 ha at Panandhro of which lignite deposits cover an area of 830 ha. The thickness of individual seams varies from 0.10 to 10.50 metres. A pit head power plant of 215 MW capacity has been installed by the state electricity board at Panandhro.

In North Gujarat, the main producing fields are in Ahmedabad/ Mehsana. Kalol, Jhalora, Nawgam, Kadi, etc. are the major fields. South Gujarat has the Ankleswar field and the large Gandhar field. The gas produced in these fields is piped to consumers within the State through two separate networks. The crude produced in the north is collected at three central tank farms at Kalol, Jhalora and Nawgam. Here the crude is separated from the water that is produced alongwith the crude and the associated gas. The South Gujarat crude is similarly collected and processed at Ankleswar and Gandhar. The entire crude oil produced in the state is piped to the refinery at Koyali for refining after removing salt in desalter plants. Apart from these major fields operated by ONGC, 12 small oil fields and 5 small gas fields are being operated by state government undertakings and private parties.

Oil Refining

The Indian Oil Corporation's (IOC) refinery at Koyali near Vadodara was commissioned in 1965 with a capacity of 3 million metric tonnes per annum (MMTPA). The current capacity is 12.5 MMTPA and this is scheduled to be expanded to 13.7 MMTPA next year. Further expansion to the capacity of 19 MMTPA is already under consideration. Reliance Petroleum Ltd. has set up a refinery at Jamnagar, which was commissioned in 1999 and has an ultimate production capacity of 27 MMTPA. Essar Gujarat is also putting up a refinery at Vadinar with a capacity of 12 MMTPA.

Fuelwood

Gujarat has a total forest area of 19,393 sq. km constituting 9.89% of the geographical area of the State. It has only 0.03 ha per capita forest area against the national average of 0.7. Over time, growth of human as well as cattle population has created enormous pressure on the forest resources of the state resulting in marked imbalance in various forests produces, especially in fuelwood. Thus, today the forests provide a meagre 0.15 million tonnes of fuelwood as against the State consumption of 7.37 million tonnes (Gujarat Forestry Action Programme 1995). Fuelwood available from non-forest lands, other than that raised under farm forestry programmes, is estimated at 1.7 million tonnes. Trees raised from the forestry component are estimated to yield 0.11 million tonnes annually. About 0.04 million tonnes comes into the State from outside. The remaining requirement is met from brushwood and agricultural waste and through over-exploitation of the forests.

An Overview of transport sector

The vehicle population in Gujarat has grown faster than the population in the state. The number of vehicles/1000 persons has increased from 3.82 in 1971 to 34.19 in 1991, representing a growth rate of 11.6% per annum. The number of vehicles/km of road has increased from 3.06 in 1971 to 21.05 in 1991 and 43.45 in 1998. The share of public transport in the vehicle composition has decreased from 5% in 1971 to less than 1% in 1997. Almost 93% of the total motor vehicles registered in Gujarat in 1995-96 were in the municipal corporations, thus suggesting that the major problems in the state due to automobile emissions are in the municipal areas. Of these, Ahmedabad (56%), Surat (25%) and Vadodadra (16%) together accounted for 97% of the total vehicles registered. The ambient air quality data for 1990-95 shows that SPM concentration has exceeded the national standard for residential areas in Ahmedabad, Vadodara, Surat and Rajkot. SO_2 concentration exceeds the standard in Vadodara, Surat and Ankleshwar probably due to the concentration of industries.

Energy Sector

In this section we examine the organisational structure, regulatory framework and the state of the environment in the energy sector in Gujarat. This would enable an analysis of the extent of integration of environmental concerns in sectoral policies.

Organisational Structure

The main departments in the Government of Gujarat which officiate over energy and environment matters are the Department of Forest and Environment, Department of Energy and Petrochemicals, Department of Mines and Minerals and the Department of Non-conventional Energy. In addition to these, the organisational structure and role of the main agencies in specific energy sectors are presented below.

Power

The Gujarat State Electricity Board (GEB), a statutory body constituted in 1960 under the Electricity (Supply) Act, 1948 is the primary organisation in the power sector in the state, responsible for generation, transmission and distribution of power. In addition there are licensees like the Ahmedabad Electricity Supply Company (AECo.), which both generates and distributes power in its franchise areas (in and around the city of Ahmedabad) and the Surat Electricity Company (SEC) which operates as a distribution licensee (in and around the city of Surat). IPPs like Essar Power limited (615 MW gas based) and Gujarat Torrent Energy Corporation (615 MW gas based) have also come up in Gujarat. Other organisations, which own generating capacity in the state include utilities owned by the Central Government i.e. the National Thermal Power Corporation (NTPC) and the Nuclear Power Corporation (NPC). The state, through GEB, has an allocation in the installed capacity of the central sector generating stations owned by NTPC and NPC. In addition, Gujarat Power Corporation Limited (a state government undertaking), Gujarat Industries Power Company Limited (GIPCL), Gujarat State Electricity Corporation Limited (GSECL) are other entities in the Gujarat power sector. The role of these organisations is highlighted below.

Box 1. Organisations in the power sector in Gujarat

Organisation	Functions
1. Gujarat Electricity Board	• Generation, transmission and distribution of electricity within the state, in coordination with other generating companies/ government agencies (and distribution licensees) operating in the state • Improving electricity supply to areas not being or inadequately supplied • Formulation of perspective plans in co-ordination with the generating companies operating in the state, for the generation, transmission and supply of electricity within the state • Collection of data on demand for electricity
2. Gujarat Power Corporation Limited (GPCL)	• Promotion of power projects in the state. • Monitoring the privatisation process of power generation in the state through inviting and evaluating private sector bids for generation projects.
3. Gujarat State Electricity Corporation Limited (GSECL)	• Objective of taking on the future generation projects of GEB.
4. Gujarat Industries Power Corporation Limited (GIPCL)	• Supply of power to Gujarat State Fertiliser Corporation, Gujarat Alkalies and Chemicals Limited, Petrofils Co-operative and GEB.

Oil and Gas

Gujarat State Petroleum Corporation (GSPC) is the nodal agency of the Government of Gujarat responsible for exploration and production of oil and gas. With the liberalisation of the oil exploration policy in 1991, GSPC was awarded five small oil and gas fields by the Government of India, and in association with the Canadian operator Niko Resources Ltd., started production of oil and gas by the end of the year 1994. As mentioned earlier, the bulk of the oil fields in north and south Gujarat are operated by the ONGC. In addition, there are 12 small oil fields and 5 small gas fields being operated by state government undertakings and private parties.

Lignite

The Gujarat Mineral Development Corporation (GMDC) is the primary agency responsible for developing strategies relating to the extraction of minerals in the state. It also operates the lignite mine at Panandhro in Kachchh with reserves of 98 MMT and at Rajpardi in Bharuch with reserves of 15 MMT.

Renewable Energy

Gujarat has been one of the leading states in terms of utilisation of renewable energy technologies. The nodal agency in this respect is the Gujarat Energy Development Agency (GEDA) established in 1979 to promote and popularise renewable energy technologies and energy conservation measures, and undertake research and development in these areas.

GEDA's objectives are to:

- Sponsor, co-ordinate and promote research programmes or projects for prototype development (demonstration projects) and pilot investigations in the area of new and renewable sources of energy
- Provide technical and financial assistance for formulation of programmes, designs and projects meant for extension of renewable energy development programmes in the state.
- Undertake or sponsor, techno-economic/socio-economic feasibility studies/cost benefit analysis
- Formulate and implement a broad based programme for conservation of energy at all stages, including extraction, conservation, distribution and consumption in all sectors of the economy.
- Study the environmental effects of all energy-related processes.
- Establish an Energy Resource Centre that will collect and collate energy and inter-related information
- Develop and support documentation services in area of energy in general and new and renewable energy sources, in particular.
- Develop communication/educational projects for widespread dissemination of energy and environmental issues.

Regulation

Legislative authority under Article 246 of the Constitution of India is split into Union and States with concurrent jurisdiction over some subjects. The seventh schedule of the Constitution provides the list of subjects reserved for the Union, those subjects related to the energy sector are listed below:

- Atomic energy and mineral resources necessary for its production
- Regulation and development of oil fields and mineral oil resources, petroleum and petroleum products

- Regulation of mines and mineral development
- Regulation of labour and safety in mines and oil fields
- Regulation and development of inter-state rivers

Thus the states have a limited role in the regulation, promotion or conservation of atomic, petroleum or coal based energy sources. The role of the state in energy legislation is limited to one subject, electricity, which is on the concurrent list. In addition states have been involved in the promotion of new and renewable sources of energy. Accordingly, we discuss the regulatory framework in the power sector in Gujarat.

The Government of Gujarat established the Gujarat Electricity Regulatory Commission (GERC) under sub section (1) of section 17 of the Electricity Regulatory Commission Act, 1998. The objective of setting up GERC was to create an institutional and regulatory framework that would provide consumers with better service/supply at an affordable price and promote higher efficiency and performance levels in the sector. The functions of the Commission as stated under the Section 22(I) of the ERC Act and additional functions as conferred by the Government of Gujarat are presented in Box 2. At present the GERC is preparing a consultation paper on tariff proposals. In addition, public hearings on the tariff proposals of the GEB were completed on March 23, 2000.

Box 2 Gujarat Electricity Regulatory Commission

The functions of the Gujarat Electricity Regulatory Commission as stated under the Section 22(I) of the ERC Act and additional functions as conferred by the Government of Gujarat are as follows.

1. To determine the tariff for electricity wholesale, bulk, grid or retail, as the case may be;
2. To determine the tariff payable for the use of the transmission facilities;
3. To regulate power purchase and procurement process of the transmission utilities and distribution utilities including the price at which the power shall be procured from the generating companies, generating stations or from other sources for transmission, sale, distribution and supply in the state;
4. To promote competition, efficiency and economy in the activities of the electricity industry to achieve the objects and purposes of this Act;
5. To aid and advise the state government, in matters concerning electricity generation, transmission, distribution and supply in the state;
6. To regulate the operation of the power system within the state;
7. To issue licenses for transmission, bulk supply, distribution or supply of electricity and determine the conditions to be included in the licenses;
8. To regulate the working of the licenses and other persons authorized or permitted to engage in the electricity industry in the state and to promote their working in an efficient, economical and equitable manner;
9. To require licensees to formulate perspective plans and schemes in coordination with others for the promotion of generation transmission, distribution, supply and utilisation of electricity, quality of service and to devise proper power purchase and procurement process;
10. To set standards for the electricity industry in the state including standards relating to quality, continuity and reliability of service;
11. To promote competitiveness and make avenues for participation of private sector in the electricity industry in the state, and also to ensure a fair deal to the customers;
12. To lay down and enforce safety standards;
13. To aid and advise the State Government in the formulation of the State power policy;
14. To collect and record information concerning the generation, transmission, distribution and utilisation of electricity;
15. To collect and publish data and forecasts on the demand for, and use of electricity in the state and to require the licenses to collect and publish such data;
16. To regulate the assets, properties and interest in properties concerning or related to the electricity industry in the State including the conditions governing entry into, and exist from, the electricity industry in the such manner as to safeguard the public interest;
17. To adjudicate upon the disputes and differences between the licensees and utilities and to refer the matter for arbitration;
18. To co-ordinate with environmental regulatory agencies and to evolve policies and procedures for appropriate environmental regulation of the electricity sector and utilities in the state; and
19. To aid and advise the State Government on any other matter referred to the State Commission by such Government.

Environmental Regulation

The Gujarat Pollution Control Board was constituted on October 15, 1974 under the Water (Prevention & Control of Pollution) Act, 1974, which came into force on March 23, 1974. With the legislation of the Air (Prevention and Control of Pollution) Act, 1981, the Board has taken up the work of air pollution control activities as well. With the enforcement of Environment (Protection) Act 1986, the Board has been assigned the responsibilities for the enforcement of the some of the provisions under this Act pertaining to the water and air pollution and management of hazardous wastes.

The Head Office performs activities concerning general policies and enforcement of various provisions of the Acts as well as general administration and co-ordination with other agencies.

In accordance with the provisions of the above Acts the Board is carrying out the following activities:

- Promotion of cleanliness of wells and streams in different areas of the State
- Prevention, control and abatement of air pollution in the State and improvement in the ambient quality
- Providing technical assistance and guidance to the polluting agencies
- Issuing directives for pollution control measures to the polluting agencies
- Advising the State Government on any matter concerning prevention and control of water and air pollution
- Approving judicious location of new industries from pollution control requirements.
- Promotion of re-use / re-cycle of sewage and trade effluent on land for irrigation
- Carrying out monitoring of rivers of the State
- Carrying out ambient air quality monitoring of the major cities of the State
- Collection and compilation of technical and statistical data relating to water and air pollution
- Laying down standards for the discharge of liquid effluent and gaseous emission
- Developing methods of treatment of effluent and air pollution control equipment
- Survey and inventorisation of the industrial units generating and handling hazardous wastes
- Identification of sites for the disposal
- Organising training programmes, seminars and workshops regarding pollution control
- Creating awareness in the public regarding environmental pollution control

Further, the Government of Gujarat has also set up institutions like the Gujarat Ecology Commission (GEC) in 1992 to evolve a comprehensive policy covering all aspects of ecological security, environmental protection, sustainability of natural resources and pollution control. As part of the institution building process, GEC has set up the Gujarat Institute of Desert Ecology (GUIDE) and the Gujarat Ecological Society (GES). The role of GUIDE is to devise suitable ecological interventions and to prevent further degradation of Kachchh district and surrounding arid regions.

State of the environment

Power generation

The TPSs operated by GEB account for bulk of the power generation in the state. The key parameters examined are stack emissions, ambient air quality, water quality, and ash handling. The analysis is based on the information compiled from the GEB, environmental audit reports of the TPS's, and field visits to some of the plants.

Some of the technological parameters of power generation in Gujarat that have implications for the environment are:

- Capacity Mix: Around 63.7% of power generation is coal-based (including lignite). This is followed by 24.1% share of natural gas/liquid fuels.
- Old vintage: Most of the GEB TPPs are old and still a part of the grid. The Dhuvrun power plant has completed its useful life, while Ukai is over 20 years old and Wanakbori 10-15 years. These power stations are in need for some form of R&M activities for life extension and efficiency improvement. The first phase of R&M schemes of Ukai, Gandhinagar and Dhuvrun TPS has been completed in the VII Plan period. The schemes have contributed to general improvement in the plant performance as well as availability at the power station. However, the efficiency of these plants has deteriorated sharply due to ageing and poor management of plant and machinery. Another important factor leading to a decline in efficiency is the inferior quality of coal. This has also resulted in an increase in plant heat rate. These power plants are designed to utilise coal with about 40% of ash content, limiting the overall design efficiency to around 36%-38%. But due to operating conditions and vintage, the actual operating efficiency is only around 31%.

Air Pollution

Stack emissions

Information related to stack emissions of particulate matter (SPM), sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) is compiled for the seven TPS's operated by the GEB. The actual emissions are compared with the standards specified by the Gujarat Pollution Control Board (GPCB) (Table 2).

Table 2 Stack emissions of SPM, SO_2 and NO_x from various TPS's in Gujarat

TPP	SPM (mg/m^3)			SO_2 (ppm)			NO_x (ppm)		
	Range	Average	GPCB standard	Range	Average	GPCB standard	Range	Average	GPCB standard
Ukai	132-1670	367	150	15-87	43.0	100	1.7-6.7	4.2	50
Gandhinagar	40-202	116	150	46-102	81.0	100	1.2-41.0	11.5	50
Wanakbori	41-1275	283	150	30-282	140.0	100	2.0-16.0	10.0	50
Sikka	120-146	132	150	71-94	82.0	100	6.8-8.5	9.5	50
KLTPS	18-196	103	150	516-1782	1079.0	100	12.0-18.0	15.0	50
Dhuvaran	3-164	79	150	neg-118	68.0	100	neg-7.9	5.6	50

Utran	11-76	46	150	0.025-0.89	0.49	100	1.8-18.4	11.0

Source: TERI 2000

Suspended Particulate matter (SPM) stack emissions

The average value of SPM stack emissions are low for Utran (gas) and Dhuvaran (oil) based power plants compared to the coal based TPS's. Amongst the coal based TPS's, the performance of Kachchh Lignite TPS (KLTPS), Gandhinagar and Sikka TPS's is relatively better since the average value are within the prescribed standard of 150 mg/m3. However, some of the high-end values in KLTPS and Gandhinagar TPS do exceed the standard. SPM emissions are a major cause of concern at the Ukai and Wanakbori TPS's. The average value at Ukai plant is more than twice the standard and the individual values go as high as 11 times the standard. Likewise, at Wanakbori plant, the average values are close to twice the standard while the individual values go upto 8.5 times the standard.

SO_2 stack emissions

The SO_2 stack emissions at Utran (gas based) are negligible. Dhuvaran (oil based) has the average value well within the standard, though some individual values do exceed the GPCB standard of 100 ppm. It may be noted that this power plant is using LSHS (sulphur content < 0.5%) and gas. Amongst the coal based power plants, the average SO_2 emission values are within the standard at Ukai, Gandhinagar, and Sikka. At Gandhinagar, sometimes a few individual values exceed the standard. At Wanakbori (coal based), the average SO_2 stack emissions are higher than the standard (1.4 times) and the individual values too are high (going up to almost 3 times the standard). At KLTPS (lignite based), there is a major problem as far as SO_2 emissions are concerned. The average value itself is almost 10-11 times the standard and the individual observations go as high as about 18 times the standard. In fact, the lowest value itself is about 5 times the standard. This is mainly due to the high sulphur content in lignite which ranges from 1.57%-2.69%. Thus, as far as SO_2 emissions are concerned, one does observe a problem at the Wanakbori TPP and a major problem at KLTPS. At present, there are no control equipment installed for sulphur control and thus suitable measures are required for the same at these two plants.

Ambient air quality

All the thermal power stations have an ambient air quality monitoring programme around their plants. The average ambient air quality values in all the power plants with respect to SPM, SO_2 and NO_x is well within the GPCB standards, as reflected in the following Table 3.

Table 3 Ambient air quality around various TPS's in Gujarat

TPP	SPM (µg/m^3)			SO_2 (µg/m^3)			NO_x (µg/m^3)		
	Range	Average	GPCB standard	Range	Average	GPCB standard	Range	Average	GPCB standard
Ukai	25-614	324	500	3-43	26	120	1-40	19	120
Gandhinagar	178-488	289	500	16-40	29	120	12-28	19	120
Wanakbori	81-1395	322	500	7-155	44	120	19-261	70	120
Sikka	165-366	235	500	Nil-14	10	120	Nil	nil	120
KLTPS	126-438	237	500	3-94	39	120	12-44	22	120
Dhuvaran	79-280	152	200	11-50	31	80	11-29	21	80
Utran	80-166	131	500	3-15	6	120	8-144	27	120

Source: TERI 2000

Water Pollution

An analysis of the combined effluent quality in various TSPs in Gujarat reveals that most of the power plants are unable to meet the total dissolved solids combined quality standard due to the saline nature of raw water taken. However, all the power plants meet the standards for domestic wastewater effluent except in a few cases for Biological Oxygen demand (BOD) and suspended solids parameters. As far as ash pond effluent is concerned, most of the power plants are unable to meet the suspended solids ash effluent quality standard. This could be attributed to the high ash content of the coal or to a break in the dyke walls.

Environmental impact of hydropower generation

Gujarat has scarce hydro resources and thus hydropower generation has a limited share (6.6%) in its total generation capacity. It has two major hydro stations namely Ukai (300 MW) and Kadana (180 MW) besides two mini power stations Ukai LBC and Panam. The only major project under implementation is the Sardar Sarovar in the Narmada valley. Some of the environmental implications of the Sardar Sarovar project are presented below.

Submergence of land

The reservoir would inundate about 37,690 ha at Full Reservoir Level (FRL), of which 18% is forested, 33% is cultivable land, and nearly 50% is waste or of low utilization potential. Submergence would cause loss of forests and agricultural lands, cultural infrastructure and some loss of wildlife habitat. In all, 245 villages of three states-Madhya Pradesh (193), Maharashtra (33) and Gujarat (19) will be affected.

Displacement of people

The most important impact of land submergence will be the displacement of population. This is, in fact, one of the most critical issues associated with large hydropower projects. It has assumed great importance today due to a widespread movement by several environmentalists and affected groups. Some inevitable consequences of the displacement of people include the loss of houses, private land, forest wasteland, public buildings etc. Although compensation is given, problems in implementation of these rehabilitation packages remain.

Loss of forest cover

The total recorded forest land that would be inundated in the above States is about 11,600 ha. Of the 6,746 ha. of recorded forest land that would be submerged in Gujarat, approximately 4,100 ha is to be forested through compensatory afforestation. This is being planned in the arid district of Kachchh.

In addition to the above impacts, construction of the dam could increase salinity of freshwater aquifers along the river and for some distance inland. Further, there could be a decline in the quantity of nutrients available in the estuarine water.

Lignite mining

The state of the environment around the Panandhro mine operated by the GMDC in Kachchh will be analysed in this section. The lignite available in Panandhro is of good quality with high calorific value but has a high sulphur content. GMDC has recently taken up the monitoring of the environment in the mine area. However, GEB has been monitoring the area around the power plant and some of the data generated by the GEB pertain to the mine area. Ambient air quality data for SPM, SO_2 and NO_x reported for 4 locations in and around the mine are shown in the Table 4 below.

Table 4. Ambient air quality

Location	SPM	SO_2	NOx	Area status
Near main gate	234	32	12	Industrial
Near lignite handling plant	377	35	10	Industrial
GMDC Mine pit office	512	16	12	Industrial
Colony premises	202	4	12	Residential

Note. National ambient air quality standard, 1994, SPM: 500 & 200 µg/cum, SO_2: 120 & 80 µg/cum, NO_X: 120 & 80 µg/cum, RPM-10: 150 & 100 µg/cum and CO: 5000 & 2000 µg/cum for industrial and residential areas

Source. Environmental audit report, GEB, 99 as cited in TERI 2000.

The concentrations are lower than the standard prescribed by CPCB for industrial and residential areas. SPM concentration at the GMDC office is observed to be marginally higher than the prescribed standard (500 μg/cum.). The RPM-10 (respirable particulate matter less than 10 μm size) concentration is found to be 14-18% of total SPM in the area. Carbon mono-oxide concentration in the area is observed to vary between 0.8 to 3.4 mg/m3 which is lower than the standard prescribed by CPCB for industrial and residential areas (5 and 2 mg/m3 respectively).

Impacts of Oil and gas on environment

Production

The major concerns associated with onshore oil and gas production are drilling waste fluids, drilling waste solids, produced water and volatile organics. Major sources of air emissions include flaring and fugitive emissions. Gas flaring in Gujarat amounts to around 400 MCM per year (more than 10% of production), but this does not produce an appreciable amount of SO_2 (Gujarat crude has less than 4ppm sulphur). Further, wastewater from ONGC's crude treatment plants are treated to a high level of purity and used for re-injection into oil fields.

Refining

Emissions of SO_2 from the Koyali refinery stand at 720 kg/hr, lower than the permitted 1360 kg/hr. SO_2 emissions have been kept low by using low sulphur fuels and optimisation of fuel consumption. In addition, the effluent quality at the Koyali refinery exceeds requirements of the Minimal National Standards (MINAS) for refineries.

Transportation

Transportation of crude oil and petroleum products could lead to marine pollution due to tanker collisions or grounding, tank washing and deballasting. Further, with the concentration of port facilities in the state and coastal movement of products increasing at the national level, tanker traffic in Gujarat is likely to increase. Also, crude import in Gujarat is likely to increase sharply once the coastal refineries reach capacity, thus this form of pollution is potentially serious.

Groundwater depletion

Groundwater irrigation accounts for nearly 77% of the total irrigated area in Gujarat. Irrigation is done largely through wells and over the years, there has been a phenomenal increase in the number of wells. Further, till 1960, tubewells were dug between 60-100 metres, but today they are bored in the range of 250-300 metres. The major contributing factors responsible for ground water depletion are intensive irrigation, proliferation of energised pumpsets and natural calamities like droughts. Declining water tables are thus emerging as a grave problem threatening the sustainability of agriculture in Gujarat. In coastal areas, the decline in the water table has given rise to the problem of salinity ingress.

Regions in Gujarat have been categorised as dark, grey and white on the basis of extent of groundwater depletion. A taluka is designated as 'dark' if groundwater extraction is 85% or more than the utilisable recharge. A 'grey' area was one where this ratio was in between 65%-85% and an area with a ratio of less than 65% was declared 'white'. Out of 19 districts in Gujarat 15% are in the over exploited, 5% in the dark zone and over 37% in the grey zone category. Hence over 20% districts are badly affected with ground water depletion and another 37% are on the verge of entering the dark zone category (Narmada Water Resources Department, 1999 cited in TERI 2000). Many districts in northern Gujarat such as Mahsana, Banaskantha, Ahmedabad, Gandhinagar, Sabarkantha and parts of Saurashtra and Kutchch are regions with severe groundwater depletion. The annual rate of decline in water tables in these regions has increased from nearly 1 metre/year in 1970 to about 2 metres/year during the last few years. The status of groundwater depletion in the talukas in Gujarat is shown in Table 5. Of a total of 189 Talukas in Gujarat, the affected Talukas are 67. Of these 28% are in the over-exploited category.

Table 5 Status of ground water depletion: affected talukas

Category	No. Of Talukas
Grey	41
Dark	7
Over exploited (OE)	19

Source. Narmada and Water Resources Department, 1999 as cited in TERI 2000.

Indoor Air Pollution

The problem of indoor air pollution in Gujarat can be traced to the dependence on biofuels for cooking, with more than 90% of rural households in 1993 using firewood and animal waste as fuel for cooking. In urban areas, the proportion of households using traditional fuels was lower at about 20% in 1993. (TEDDY 1999-2000). Further, fuelwood accounts for 36.5% of the total energy used by households in Gujarat (Gujarat Wood Balance Study 1984). The burning of biofuels, especially in inefficient cook-stoves leads to high levels of indoor air pollution, causing eye and lung diseases.

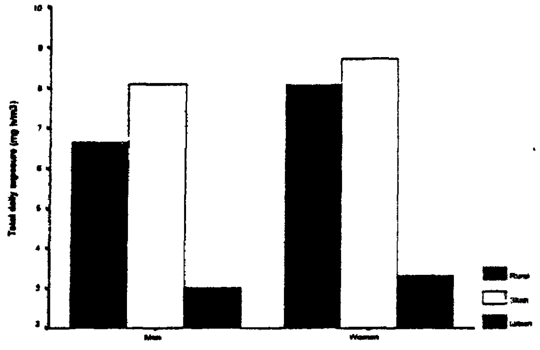
A study on Environmental Risks in Ahmedabad done by CEPT, Ahmedabad in 1995 brought out that the indoor air quality is of concern in households using fuels like wood, dung, charcoal & kerosene and a mix of these. With nearly 41% of the city's household cooking needs dependent on these fuels, combined with almost no ventilation in the slum households and low efficiency devices, the indoor ambient air levels in these low income households cause severe respiratory problems, especially in the already under-nourished female and children. The problem however is not present in the rest 60%

households, mostly higher income groups, which use liquefied petroleum gas for cooking needs.

In addition to available empirical evidence of indoor air pollution from studies conducted by CEPT (and the National Institute of Occupational Health), we undertook an estimation of the health effects of total exposure to particulate matter. The objective of the exercise was to estimate the incidence of mortality and morbidity on different groups (men, women, rural, urban etc.) in Gujarat due to particulate matter (PM10).

The results of the estimation indicate that by considering indoor sources of pollution as well as occupational exposures, the mean exposure is highest in the case of female slum dwellers. In fact, for all groups, women experience higher exposure levels than their male counterparts (Figure 3). Female workers have the highest exposures because they experience pollution not only outdoors and at the work place, but also while cooking.

Figure 3 Total daily exposures (mg h/m^3)
Source: TERI 2000



Scarcity of fuelwood supplies
As mentioned in the earlier section, fuelwood contributes 36.5 per cent towards the household energy basket in Gujarat. The total annual household fuelwood consumption is 7.007 MMT. In addition, 0.365 MT of fuelwod is consumed for cremation, in hostels, restaurants and hotels, sweetshops, industries, etc. Thus, the total fuelwood requirement figures at 7.372MT. As against this, recorded fuelwood supply is only 2.00 MT, with the remaining requirement being met from brushwood, agricultural waste, trees raised on non-forest lands and unrecorded supplies from forests. This deteriorating fuelwood supply position is reflected in increased time and travelling distance for women and children who collect the fuelwood.

Transport Sector

To highlight the environmental impacts of increasing vehicular population in Gujarat, we undertake a case study for Ahmedabad city. Almost 93% of total motor vehicles registered in Gujarat in 1995-96 were in the municipal corporations, of which Ahmedabad accounted for 56%. Surat and Vadodara accounted for 26% and 17% respectively of the motor vehicles regisered. Thus, the major problems due to automobile emissions are in the municipal areas and the analysis for Ahmedabad is indicative of the extent of the problem in the other cities as well.

The population of Ahmedabad city is increasing rapidly. The population has grown from 5.91 lakhs in 1941 to 35 lakhs in the year 1991. It is expected to increase to 46 lakhs by 2001 and 60 lakhs by 2011. Moreover, the growth of vehicles has out paced population growth. Two wheelers are the dominant mode of transport, comprising 69% of total vehicles in Gujarat. About one-third of households own one or more motorised vehicles.

A simple model for analysing urban transport issues and options was developed using a computer based software called Long Range Energy Alternatives Planning (LEAP)[3] and the associated Environmental Database (EDB). The model shows that pollutant emissions have gone up steadily, as shown in the Figure 4 below.

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[3] LEAP is a computer based accounting and simulation tool designed to assist policy makers in evaluating energy-environment policies It has been developed by the Stockholm Environment Institute - Boston (SEI, 1993).

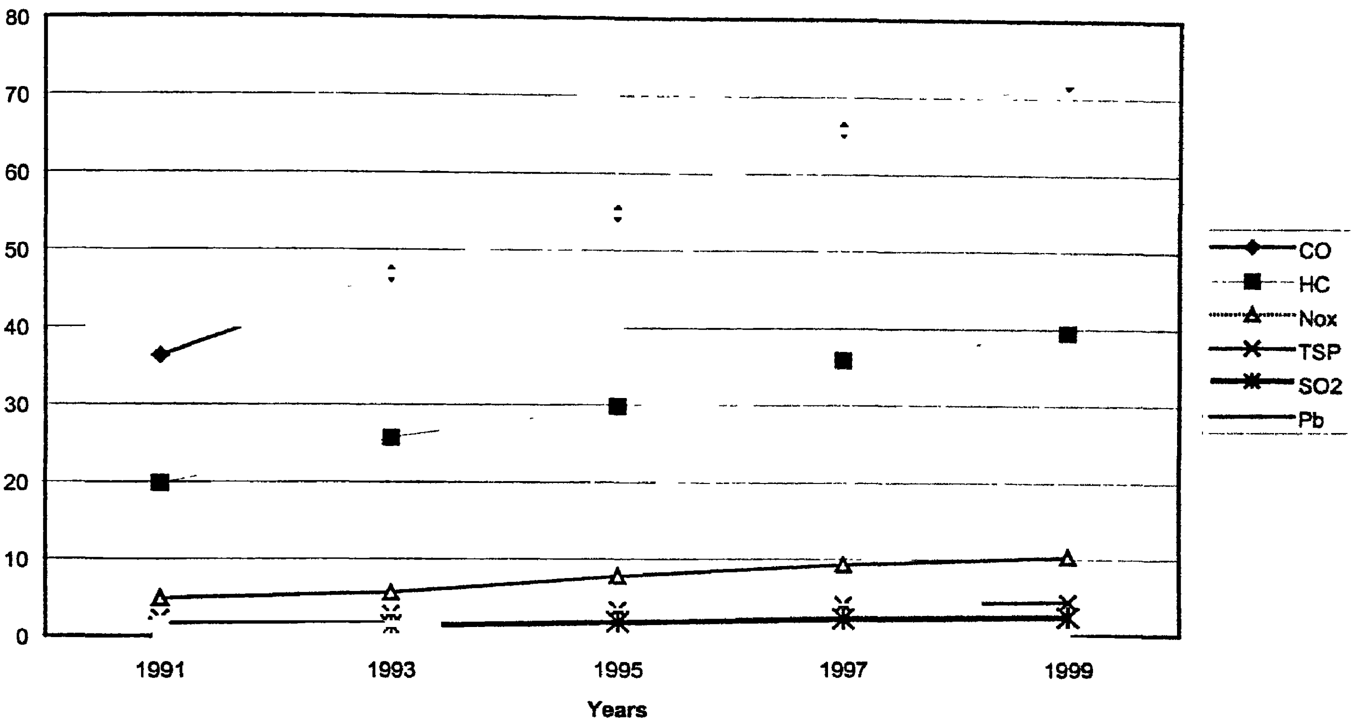


Figure 4 Trends in emission

Empirical evidence

A CPCB study of vehicular pollution load in Ahmedabad in 1987-88 indicated a vehicular emission load of 209 tonnes a day of which nearly 64% comprised carbon monoxide. It was estimated in 1994 that carbon monoxide had increased to 74% of the transport load. Exposure to carbon monoxide levels at certain locations in the city were high enough to cause carboxy-haemoglobin level in blood to rise by 2 to 5 percent. Use of kerosene in three wheelers in a ratio of over 70% kerosene with petrol resulted in excessive emission levels, further degrading the air quality. A test of vehicular exhaust emission conducted by Consumer Education and Research Centre (CERC), Ahmedabad, in May 1993 on 2 wheelers, 3 wheelers and cars indicated that 65% of 2 wheelers, 55% of 3 wheelers & 70% of four wheelers had emissions above permissible standards for both CO and hydrocarbons.

Conclusion

The data presented above is for Ahmedabad but there are enough indications of similar problems in Vadodara and Surat and to some extent in Rajkot. The problem arising out of vehicular emission in Ahmedabad, Vadodara and Surat is of serious and immediate concern.

State of the Environment Matrix

The analysis presented above is summarised below in the form of a matrix that identifies the major environmental impacts arising in the energy and transport sectors in Gujarat, the trends in these impacts and their causes.

State of the environment matrix for Gujarat

Problem & location	*Trends*			**Causes**		**Impacts**
	Current (Immediate)	**Next 5 years (emerging)**	**Beyond 5 years (long-term)**	**Socio-economic/ technical**	**Policy**	
1. Power generation						
Ukai & Wanakbori - High SPM emission from coal based plants	Not increasing but already at a high level	Could be reduced by installing more efficient ESPs	Could be reduced by installing more efficient ESPs	Old plants, inadequate R&M, inferior coal, low operating efficiency of pollution control equipment	Inadequate enforcement of pollution regulation.	Degradation of ambient air quality, health of workers and residents
KLTPS & Wanakbori - High SO_2 emission from coal and lignite based plants	KLTPS – High but within norms Wanakbori – Exceeding norms at times	Could be reduced by installing FGD units	Could be reduced by installing FGD units	KLTPS – use of high sulphur lignite Wanakbori – Large size of plant		Degradation of ambient air quality, health of workers and residents
All coal fired plants Ground water contamination, land degradation & ash emission during handling & transport	Ash emission – on the increase as flyash has to be transported over longer distances	Likely to increase	Likely to increase	High ash content of domestic coal		Degrades water and air quality, near ash ponds and en route to landfill sites Reduces land availability.
KLTPs, Ukai & Sikka – High dissolved solids in effluents	Total dissolved solids far above the norms	Could be reduced by proper treatment	Could be reduced by proper treatment	Poor quality of input water, operating efficiency of treatment plant		Water quality, riverine and coastal fisheries
Hydropower plants at Ukai & Kadana – damage to forests and fisheries				Submergence of forests & drying up of downstream river		The upstream & downstream ecology, economy of forest villagers, fishermen
2. Lignite mining at Panandhro						
Land degradation	Slowly increasing as new sites are taken up for mining	Likely to increase	Likely to increase		Land reclamation not enforced	May have long term impacts on local ecology
Dust emission	Under control as the lignite is moist & water is sprinkled	May reduce	May reduce	Mining, vehicle movement inside mines		Ambient air quality, health of workers

Problem & location	*Trends*			**Causes**		**Impacts**
	Current (Immediate)	**Next 5 years (emerging)**	**Beyond 5 years (long-term)**	**Socio-economic/ technical**	**Policy**	
SO_2 emission from spontaneous burning of coal	Does not appear to be serious as ambient air quality around the mine within norms.	Could be kept under control by appropriate mining practices	Could be kept under control by appropriate mining practices	Exposure of lignite to air		Ambient air quality, health of workers
3. Automobile emissions						
Ahmedabad Surat, Vadodara, Rajkot – High level of emission of CO, HC, NO_x & SO_2	Emission levels high and increasing	Will continue to increase	Increase could be checked through policy intervention	Rising population and incomes, urbanisation	Inadequate public transport and infrastructure	Ambient air quality and health of residents
4. Indoor Air-pollution						
Rural and urban low income groups all over the state	Exposure levels high	May reduce slowly due to rising incomes and better designed chulahs	Substantial reduction may be expected	Poverty, lack of access to alternative fuels	Relative pricing of fuels	Indoor air quality, health of women and children
5. Deficit in fuel-wood supply						
All over the state	Deficit increasing	Will continue to increase	Expected to reduce due to rise in incomes and afforestation measures	Poverty, lack of access to alternative fuels	Relative pricing of fuels	Depleting forest cover, greater strain on women
6. Groundwater depletion						
Sixty seven talukas severely affected	Water table declining in the affected talukas	May continue to decline	Could be controlled by proper policy measures	Lack of surface water sources	Unmetered supply of electricity, low agricultural tariffs	Depletion of ground water reserves
7. Marine and coastal pollution due to oil spills						
Coastal Gujarat, major and minor ports	Movement of tankers carrying petroleum products on the increase	Will continue to increase	Will continue to increase unless policy intervention are made on grounds of security of supplies	Location of the state and availability of ports		Oil spills likely to affect marine life, coral reefs and mangroves

Review of extent of integration of environmental concerns in sectoral policies - Policy recommendations

In this section we review the extent to which environmental concerns have been integrated in policies in the energy and transport sectors. In particular, the problem areas (in terms of environmental impacts) identified in the above matrix have been analysed and policy recommendations for these identified.

Energy Sector

Power

The main causes of high SPM and SO_2 emissions from coal and lignite based plants are the inadequate R&M, high ash content of coal, high sulphur content in lignite, poor maintenance and therefore low efficiency of pollution control equipment and inadequate enforcement of pollution regulation. Further, unmetered electricity supply and low electricity tariffs for agricultural consumers have contributed to excessive groundwater extraction in the state. Thus adoption of R&M programs, installation and optimum utilisation of pollution control equipment, effective monitoring and enforcement of pollution regulation must be part of any strategy for the power sector. Further, targeting and phased reduction of power subsidies, restructuring of tariffs and development of renewable energy technologies should be the thrust areas for reform in the power sector.

Lignite mining.

Some policy recommendations for this sector based on a review of mining practices in Gujarat are presented below.

1) **Land reclamation** - Mining activity has degraded large portions of land in the process of top soil and overburden removal, and external dumping. A systematic approach needs to be followed to reclaim and restore the overburden dumps. External dump is the major source of soil erosion, with the high dump and steep slope being contributing factors. This affects river courses during rainy season due to run off carrying loose soils. Suitable technical and biological reclamation and construction of garland drain around dumps would stabilise and prevent soil run off.
2) **Dust exposure monitoring** – All workers, especially those engaged in hand picking of lignite are exposed to finer particulate matter. Long term exposure might lead to respiratory diseases. Personal protection, monitoring and assessment need to be adopted to safeguard workers.
3) **Improving livelihoods** - Mining development has provided an economic opportunity in adjoining areas by developing infrastructure, medical, school & banking facilities, etc. However, large migration of population has posed a problem to the local people, apart from burden on land and water resources. These concerns should be reflected in the development of a management plan to encourage public participation and avoid any social conflicts that may arise.
4) **Role of state pollution control board** - The state pollution control boards have a major role to play in ensuring environmental quality in mining areas as they are responsible for monitoring and enforcement of environmental standards. However this monitoring has been inadequate due to limited physical checks. The granting of consent of operation or environmental clearances to mining companies (both for new

operations and renewal of old) should be strengthened based on stringent review of environmental statements presented.

5) **Strengthening environmental reporting system** – The submission of environmental audit reports and environmental statements by the mining companies to the GPCB must be ensured. Further, the quality and accuracy of data presented in these reports must be ensured through the strengthening of primary environmental data gathering and reporting. These statements should also entail a check of whether requisite environmental infrastructure like health and safety monitoring equipment and personnel (doctors) are available.
6) **Co-ordination between state departments** – Mining companies have to obtain site clearances and environmental clearances from state departments such as the department of land and revenue, and the department of forest and environment. These clearances are given on the basis of commitments made by the mining companies to use the land leased in an ecologically sustainable manner. Co-ordination between these departments and the state pollution control board could ensure that these commitments are adhered to, through instituting a follow-up mechanism.

Residential energy use

The problem of indoor air pollution is one of the most crucial problems facing the state of Gujarat, in terms of its impact on the poor sections of society, women and children. Poverty and the resultant lack of access to alternative fuels are the main drivers behind the deterioration in indoor air quality and the state of forests. Thus policies aimed at poverty alleviation should be the main focus for reducing these problems. Some additional policy recommendations are highlighted below.

1. In rural areas, in addition to programs for the introduction of improved chulhas, research efforts could be directed towards the development of cleaner biomass-based fuels like biogas.
2. In urban areas, policies aimed at facilitating a switch from biofuels to cleaner fuels like LPG should be encouraged.
3. Construction of new housing for poorer sections of society should incorporate design aspects such as proper ventilation which would help reduce the problem of indoor air pollution.
4. Greater co-ordination in policy making between the departments concerned with non conventional energy sources, urban development, environment and forests and health is required.

Transportation of petroleum products

The existing strategy in India to tackle marine pollution includes the National Oil Spills Contingency Plan issued in 1998 by the Indian Coast Guard. The agencies responsible for combating this form of pollution in addition to the Indian Coast Guard include the Port authorities, the Coastal State Pollution Board and the ONGC. The role of various organisations in implementing the plan is as follows.

- The Indian Coast Guard is entrusted with the additional statutory duty of marine environmental preservation, protection and pollution response in the maritime zones. It is responsible for implementation and enforcement of relevant marine pollution laws including the National Oil Spill Disaster Contingency Plan.
- The Port authorities are responsible for response to accidents within port limits.
- The Coastal State Pollution Board would be responsible for combating oil spill contingencies that occur on shore.
- The oil and petroleum exploration and production agencies (ONGC) would be responsible for instituting preventive measures for monitoring, controlling and combating an oil spill within 500m of its installations. Beyond this distance it would supplement the efforts of the Coast Guard.

Further, a task force to develop oil spill response facilities was created at the initiative of the ONGC, comprising industry members, with the Oil Industry Safety Directorate (OISD), Ministry of Petroleum and Natural Gas acting as the nodal agency. The task force suggested the creation of five centres, one each at Haldia and Kakinada with the capability of handling oil spills upto 1000 tonnes and at Mumbai, Chennai and Vadinar with capability to handle spills above 1000 tonnes. (B C Kapale and J S Thakur. 1999).

Development of renewable energy

Gujarat has been a pioneering state in the field of renewable energy development. It was the first state to establish the state nodal agency GEDA for the development and dissemination of renewable energy technologies in the state. Its biogas programme is one of the most successful programmes in the state with a high success ratio in managing energy co-operatives, community and institutional biogas plants. Similarly, a pioneering experiment was the establishment of Integrated Rural Energy Centres (Urjagrams) where most of the energy needs of a village could be met using locally available renewable energy resources. The state also has one of the most extensive wind-mapping programs. Rural Energy Assessment Surveys in 200 representative villages and 15 blocks have led to the creation of an extensive database for planning rural energy strategies. Gujarat has also been in the forefront in the domestic and industrial applications of solar energy, especially for water heating in dairies and other process industries, and solar cooking. However there exists considerable potential for developing renewable energy sources further in Gujarat, as presented in the table below.

Table 6. Renewable energy potential in Gujarat

Source	Energy Generation Potential
Solar energy	3 x 10^{14} kWh
Biomass	900 MW
Biogas	5.6 million m^3 of biogas per day (adequate for supplying cooking gas to 2.8 million families) or 933 MW
Energy plantation	67 million tonnes of biomass, (adequate for generating 15000 MW)
Wind	5000 MW
Tidal	10000 MW

Source: GEDA 1994

There exists potential for utilising hydrogen, from solar-assisted electrolysis of water, either for direct burning or for decentralised electricity generation through fuel cells, for both stationary and on-board vehicular applications. With a number of Chlor-alkali industries in Gujarat, fuel cells could be effectively used for meeting heat and power requirements. Moreover, fuel cells based on coal (or lignite) gasification and natural gas could be used for supplying decentralised power. Besides, renewable energy can also be used cost-effectively for other applications, such as water desalination. Considering the acute shortage of drinking water in various parts of the state, especially Kachchh and Saurashtra, there is vast potential for utilising solar energy for desalination purpose. This would also benefit those industries that are situated in these water-scarce areas.

As elaborated earlier, the use of conventional energy sources in the state has lead to a threat to the eco-system in the state through the degradation of air, water and land. Development of renewable energy in the state can reduce dependence on fossil fuels, play a complementary role to conventional power systems and reduce environmental impacts arising in the energy sector. Development of renewable energy also has the indirect impacts of building an industrial base and technological capacity, which can improve livelihoods, especially in rural areas. It is thus one of the most significant strategies for the integration of environmental concerns in energy sector policies.

Transport sector

The technological and policy causes of rising automobile emissions in the city of Ahmedabad are highlighted below. These provide indicators of the main areas where policy initiative is required to curb pollution emanating from the transport sector in Gujarat.

Carbon monoxide emissions in Ahmedabad increased from 3.6×10^4 to 7.2×10^4 tonnes between 1990/91 to 1998/99 (TERI 2000). Gasoline-driven vehicles contribute the bulk of CO emissions. Of these, scooters/ motorcycles and autorickshaws, which have mostly two stroke engines, currently contribute nearly 79% of the total CO emission in Ahmedabad. These emissions increase because it is not mandatory for vehicles to fix catalytic converters.

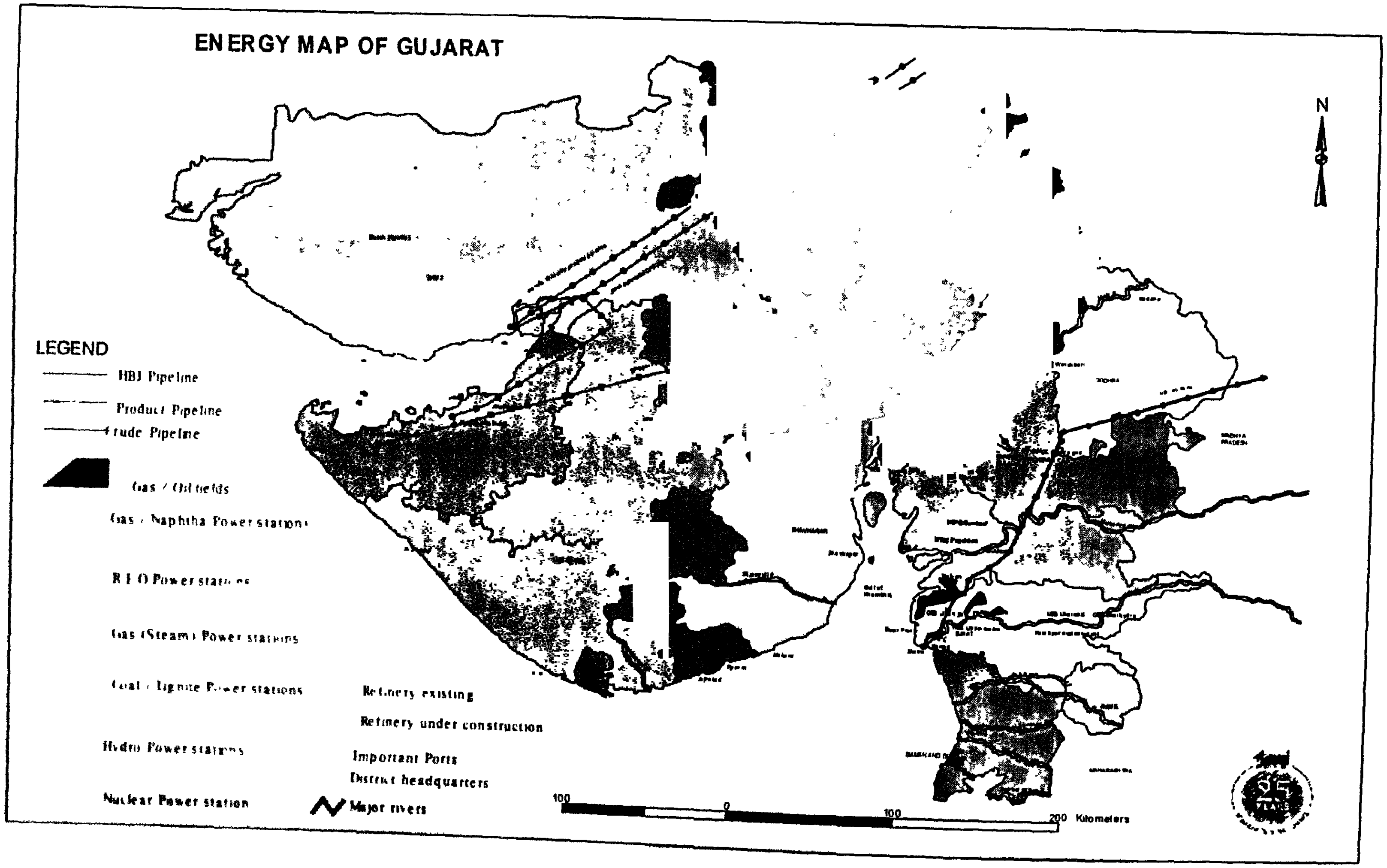
HC emissions rates are higher in gasoline than diesel vehicles due to lower combustion efficiency in gasoline engines. Among the gasoline-driven two- and three-wheeled vehicles, two-stroke engines are highly inefficient as compared to the ones with four-stroke engines. In 1998/99, over 90% HC emissions were contributed by scooters, motorcycles and autorickshaws in Ahmedabad. No effort has been made towards introducing four-stroke engines in autorickshaws. As a result, HC emission contribution from these vehicles would increase dramatically if two- and three-wheeled vehicles with two-stroke engines continue to grow at their present pace.

The use of diesel in the transport sector contributes significantly to emissions of SO_2, NO_x and TSP. The emission rate of NO_x is higher in diesel driven heavy duty vehicles (like buses and commercial goods vehicles) because of lower combustion temperatures as compared to gasoline vehicles. Buses contributed nearly about 50% of the total NO_x emissions in Ahmedabad in the year 1998/99. Further, emission rate of SO_2 is higher in diesel than gasoline vehicles. In 1998/99 nearly 47% of the total SO_2 was contributed by cars. Two and three-wheeled vehicles contributed relatively less SO_2 emission. In addition, diesel vehicles emit significant TSP as compared to gasoline vehicles. In 1998/99, about 37% of the total TSP emission in Ahmedabad was from scooters and motor cycles.

Conclusions

The analysis presented above for the energy and transport sectors in the state of Gujarat has helped identify the key points of environmental stress in these sectors.

The problems of indoor air pollution, groundwater overuse, automobile emissions and hydropower generation are environmental impacts which affect a large number of people in the state, especially those that belong to weaker sections. In addition, emissions and effluents from power plants and marine pollution are areas of concern in the energy sector. To tackle these problems, policy recommendations for each sector have been presented earlier. In particular, the state should focus on the use of cleaner fuels such as gas and renewable energy sources. Finally, poverty alleviation programs, which would improve the access of the poor to cleaner fuels, should be encouraged.



ENERGY MAP OF GUJARAT

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